BACKSCATTER OF MILLIMETER WAVES FROM SNOW, ICE AND SEA ICE

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BACKSCATTER OF MILLIMETER WAVES FROM SNOW, ICE, AND SEA ICE

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31 December 1972

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CONTENTS

		page
SUMMARY		ii
	Introduction.	1
I.	Laboratory Measurements of the Dielectric Constant of Sea Ice.	2
II.	Backscatter Measurements from Snow, Ice and Sea Ice	5
III.	Conclusions	18
	References.	19
APPENDIX.		20

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13. ABSTRACT

The factors contributing to the scattering of electromagnetic waves from snow, ice, and sea ice are discussed. Laboratory measurements of the complex permittivity of sea ice as a function of temperature and salinity are reported for the frequency range 26-40 GHz. Bistatic field measurements of backscatter are also described, and results presented for a wide variety of conditions of snow cover and ice topography. Surface topography and liquid water content are dominant contributors to backscatter.

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BACKSCATTER OF MILLIMETER WAVES FROM SNOW, ICE, AND SEA ICE

by W. M. Sackinger and R. C. Byrd

INTRODUCTION

One of the objectives of the Advanced Research Projects Agency (ARPA) in recent years has been the critical examination of defense problems in the Arctic. The mobilization and transport of personnel and equipment in the Arctic is a monumental logistics challenge. The Arctic Ocean is covered during most of the year with a continually shifting layer of sea ice, driven by winds and ocean currents. Open leads and pressure ridges present hazards to most forms of surface transport. The Surface Effect Vehicle (SEV) exhibits enough versatility to cross ice, water, and low pressure ridges. Development of a surface effect vehicle for Arctic use has been a major focus of the ARPA program. The SEV must be able to locate these hazards under conditions of darkness and blowing snow which often prevail in the Arctic. Preliminary consideration of the several approaches to a terrain avoidance system leads one to the use of millimeter wavelength radars. Very little is known of the backscatter cross-section of snow, sea ice, and combinations of them. This study was therefore initiated as a supporting engineering research effort to determine the backscatter cross-section of these Arctic surfaces. It has considerable additional

use in the interpretation of photographs taken with side-looking airborne radar (SLAR). Many reconnaissance flights have been made in the Arctic using SLAR remote sensing techniques.

The energy backscattered from a dielectric surface is dependent upon the dielectric constant and also upon surface topography. The dielectric constant ε is complex for snow, ice, and sea ice, with an imaginary part which corresponds to the energy loss within the material.

The approach taken in the program was therefore to make laboratory measurements of the complex dielectric constant of those materials for which no data previously existed; and to make field measurements of backscatter on actual undisturbed snow-covered terrain, ice, and sea ice. In this way, it was hoped that the influence of the dielectric constant on the backscatter could be separated from the effect of surface topography.

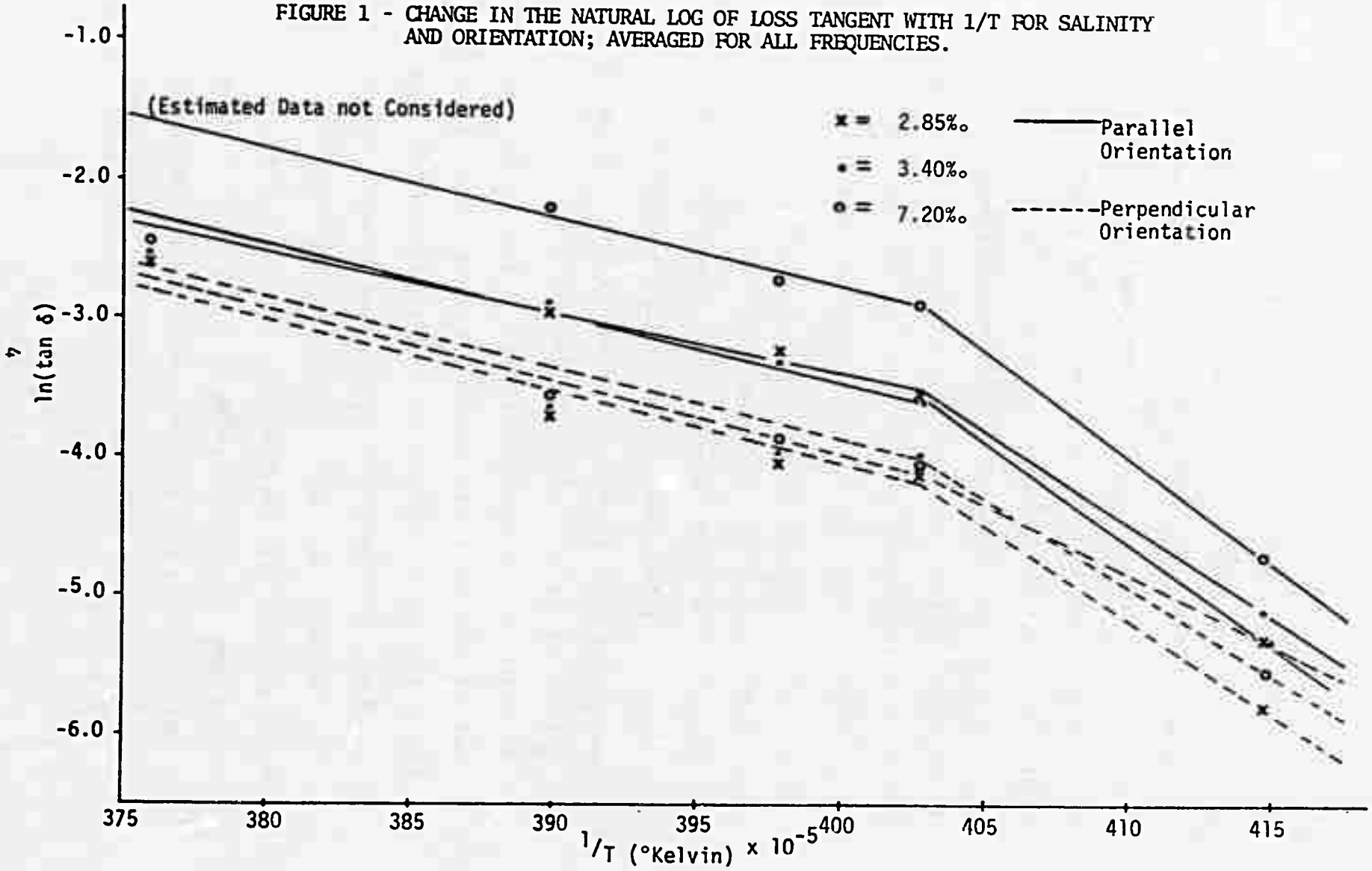
I. LABORATORY MEASUREMENTS OF THE DIELECTRIC CONSTANT OF SEA ICE

During the first six months of this study, laboratory measurements were made of the dielectric properties of sea ice in the frequency range 26-40 GHz. These measurements were carried out by Mr. R. C. Byrd and are reported in detail in his M.S. Thesis (December 1971), and in the First Semi-Annual Technical Report[10] of this contract. Measurements were made of the complex dielectric constant of representative samples of naturally occurring

sea ice, as a function of temperature, salinity and orientation. Sea ice may be considered to be a mixture of dielectrics if the size of the inhomogeneities is small compared to a wavelength. This condition was obeyed for most samples. At temperatures warmer than -21°C, sea ice may be regarded as a two-phase mixture of liquid brine inclusions and relatively pure ice crystals. At temperatures colder than -21°C, the brine inclusions begin to freeze, and a simplified model with two solid phases (ice crystals and frozen brine inclusions) may be used. The dielectric loss in the frequency range under study, 26-40 GHz, is due to the dipole molecule of liquid water.[1] Measurements by Hoekstra[2] at lower frequencies have shown considerable loss in sea ice due to the presence of the liquid brine inclusions. An abrupt change in loss tangent was indeed observed at about -22°C for each sample, which was undoubtedly related to this effect. Figure 1 summarizes the variation of the loss tangent with temperature.

An additional effect shown in Figure 1 is that the loss tangent depends upon the relative orientation of the electric field with respect to the direction of the brine inclusions. The brine inclusions are often approximately planar, and it was discovered that the loss was as much as a factor of four greater when the waveguide electric field was parallel to the brine inclusions, as compared to when the field was perpendicular to them. The normalized real part of the complex permittivity is nearly constant and equal to 3.10 over the frequency range 26-40 GHz. The variation

FIGURE 1 - CHANGE IN THE NATURAL LOG OF LOSS TANGENT WITH 1/T FOR SALINITY AND ORIENTATION; AVERAGED FOR ALL FREQUENCIES.



of loss tangent with salinity is illustrated in Figure 2 for several temperatures, at the frequency of 34 GHz. Generally, the loss tangent increases with salinity at any given temperature.

The data observed is consistent with qualitative expectations based upon dielectric mixing theory. A considerable amount of theoretical calculation remains to be done to give quantitative explanation of the observed behavior. Time limitations required postponement of the appropriate theoretical calculations.

II. BACKSCATTER MEASUREMENTS FROM SNOW, ICE, AND SEA ICE

Considerable attention has been given in the literature to the scattering of electromagnetic waves from rough surfaces.[3-6] One of the most restrictive assumptions in most of the theories developed to predict rough surface scattering is that the irregularities of the scattering surface occur on a scale either large compared to the wavelength or small compared to the wavelength. Casual observation of snow, ice, and sea ice leads one to believe that these approximations would often be obeyed for millimeter wavelengths, but there are numerous instances where the size of the snow crystals or sea ice surface features may be of the same order as the wavelength. The dielectric properties of snow, ice, and sea ice are also contributors to both forward scattering and backscattering, as are the surface topographical features. Our study was concerned with backscatter of both

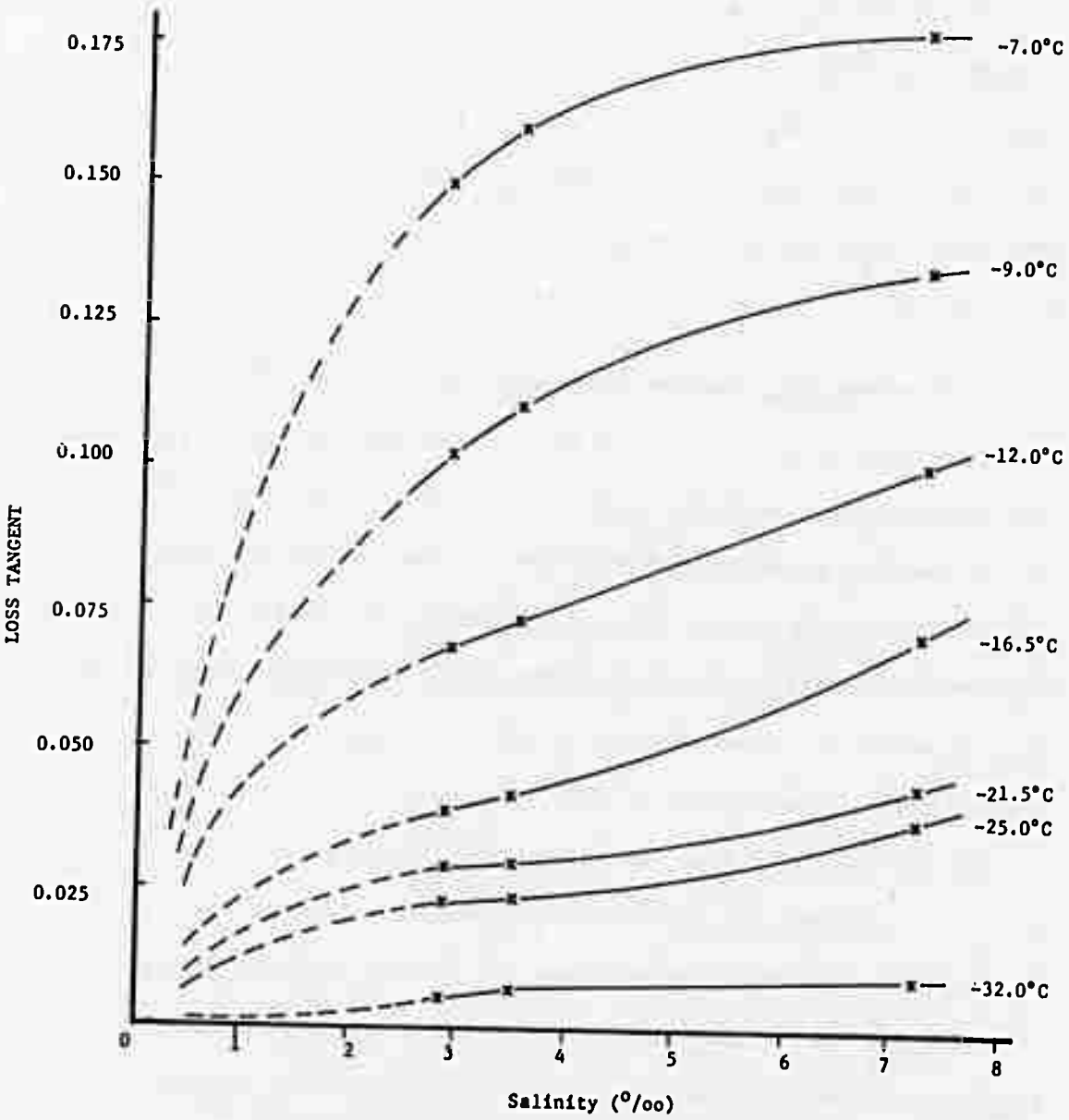


Figure 2 - Loss Tangent versus Salinity for Several Temperatures in Natural Sea Ice, at the Frequency 34 GHz.

horizontally and vertically polarized electromagnetic waves from snow-covered land, fresh ice and sea ice.

Our measurements were carried out at 35 GHz in the field. Laboratory measurements were made on sea ice of varying salinity and temperature as reported above. Preliminary laboratory measurements on snow proved to be difficult to interpret because of the low density, the low loss, and the lack of reproducibility of the snow characteristics within a tiny waveguide. Field measurements, however, were made on sea ice, fresh ice, and frozen ground, with several different conditions of snow cover.

The salt exclusion process results in the presence of brine on the surface of the sea ice in the early stages of freezing.[7] This brine causes any snow which might also be present to adhere to the surface of the new ice. This process has been found by the authors to result in a sea ice surface which is rough on a millimeter scale and which invariably has a snow cover, as contrasted with fresh water ice, which (depending upon wind conditions) can sometimes have a smooth surface, free of snow. A model approximating this relationship, derived from our visual observations, is shown in Figure 3.

For the field measurements, a bistatic method of measuring backscatter was used involving two adjacent identical horn antennas, each with 22° vertical by 24° horizontal beamwidth measured at the -3 dB points, and having a gain of 16.9 dB at 35 GHz. These antennas were mounted with axes parallel on a

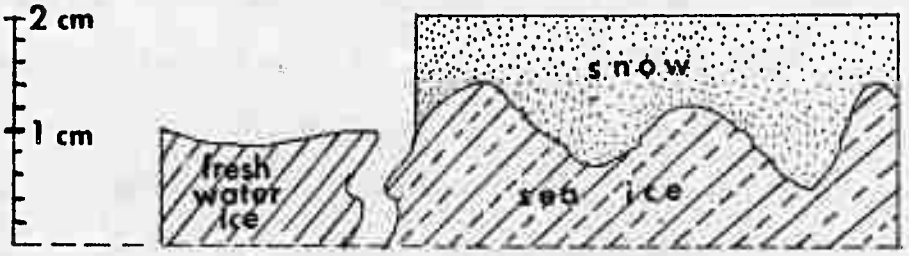


FIGURE 3 - COMPARISON OF THE SURFACE CONDITION OBSERVED IN FRESH AND SEA ICE, SIMPLIFIED TO SHOW THE RELATIVE ROUGHNESS OF THE SURFACES.

special fixture which permitted each antenna to be rotated on its axis by $\pm$ 90°. Each antenna was fed by a waveguide operating in the TE_{10} mode so that the waves from each antenna were linearly polarized. It was thus possible to measure backscatter for horizontal, vertical and crossed polarization cases. Of primary interest was the variation in backscatter as the angle of incidence was varied. The antenna fixture was mounted on a track which extended along the periphery of a quarter of a circle, and which was erected vertically over the snow area under examination. The center of the circle of rotation was always chosen on the top surface of the snow or ice, and the radius of rotation of the antennas was a constant distance of approximately two meters from the focal point. At each angular setting, a minor adjustment in operating frequency was made to optimize the reflected power since the random phase relationship of the scattering centers gave rise to an arbitrary location of the voltage maximum.

The continuous wave output signal was amplitude-modulated, and the reflected signal was detected and measured with a phase-locked amplifier. The crystal detectors were carefully calibrated as a function of temperature. The sensitivity of the receiver was approximately 75 dB below the output signal, depending strongly upon local interference, with an accuracy of 0.5 dB.

In the interpretation of the data obtained, it should be

remembered that there is an unavoidable averaging over a range of angles, due to the finite beam width of the antennas used. This limitation is inherent in any measurements made on scattering surfaces. The distance from the antennas to the scattering surface is a very large number of wavelengths at 35 GHz, comparable (in wavelengths) to the distances involved in backscatter measurements conducted at lower frequencies.[8] A dependence upon the inverse fourth power of the distance between antennas and the scattering surface is to be expected, typical of the radar range equation. However, as the angle of incidence is varied from normal incidence to grazing incidence, some of the power reflects back from the very close snow surface beneath the fixture, and some of the power escapes to distances very far from the fixture. This is a consequence of the fact that the illuminated area has dimensions which are <u>not</u> negligible compared to the distance from the source to the scattering surface. Since the snow surface close to the antenna will contribute more to the received power than the snow surface much further away, the effective average angle of incidence is different from the geometric angle of incidence. A calculation was made assuming that the incident power could be decomposed (in an optical fashion) into many rays diverging from the source antenna. The $1/r^4$ calculation from the range equation was made for each ray, and a weighting factor was computed for each ray which

expressed its relative contribution to the total received power. The new effective primary angle was then chosen so that there was an equal amount of power reflected into the receiving antenna from both sides of that ray corresponding to the new effective angle. As a result of this angular correction, the case of grazing incidence was only approached with this antenna. The corrected angle ranged from 52.5° for a 50° geometric angle, to 19.2° for a 10° geometric angle.

An intensity correction also appeared to be necessary, inasmuch as the principal ray became closer and closer to the scattering surface as the incident angle was moved from normal incidence to grazing incidence. Again using the inverse fourth power variation inherent in the range equation, a correction in received power was made at each angle of incidence to allow for this effect. The resulting relationship between intensity and incident angle was then used as a basis for calculations of the normalized backscattering cross-section γ. The definition of γ which was used is that given by Barrick.[5]

$$\gamma = \frac{\sigma}{A},$$

where σ, the equivalent echo area of the illuminated region, is taken from the range equation

$$\sigma = \frac{P_r}{P_t} \frac{(4\pi)^3 R^4}{\lambda^2 G^2}$$

Computer calculation and automated data plotting were employed to reduce the data reduction time. In the curves which were

derived, the top of the snow surface was used as a reference. From laboratory results mentioned above, in the case of sea ice the penetration of the wave is very small, (of the order of a few centimeters or less for most conditions of temperature and salinity), and therefore this approximation should be valid. On the other hand, waves penetrating cold, dry snow certainly pass through the snow and strike the relatively warm, large, depth-hoar snow crystals at the surface of the ground. In the case of snow there is a continuous refraction and backscatter throughout the depth of the snow layer, so that the calculations which were made based on a well-defined backscatter plane are not directly related to the physical location of the scattering centers. An example of the result is given in Figure 4, which compares the normalized backscattering cross-section γ for typical, undisturbed annual sea ice and undisturbed fresh water ice. These measurements were taken with horizontal polarizations, at 35 GHz, under identical meteorological conditions (the air temperature was -20°C) on a fresh water lake and an adjacent salt water lagoon. For this comparison, an effort was made to find sea ice with as little snow cover as possible. Snow depth was 2.5 cm on the sea ice and zero on the fresh ice.

At normal incidence, the fresh water ice yields a stronger reflection, contrary to expectations based upon dielectric permittivity alone. The surface roughness of the sea ice therefore plays a major role in reducing the effective areas for specular

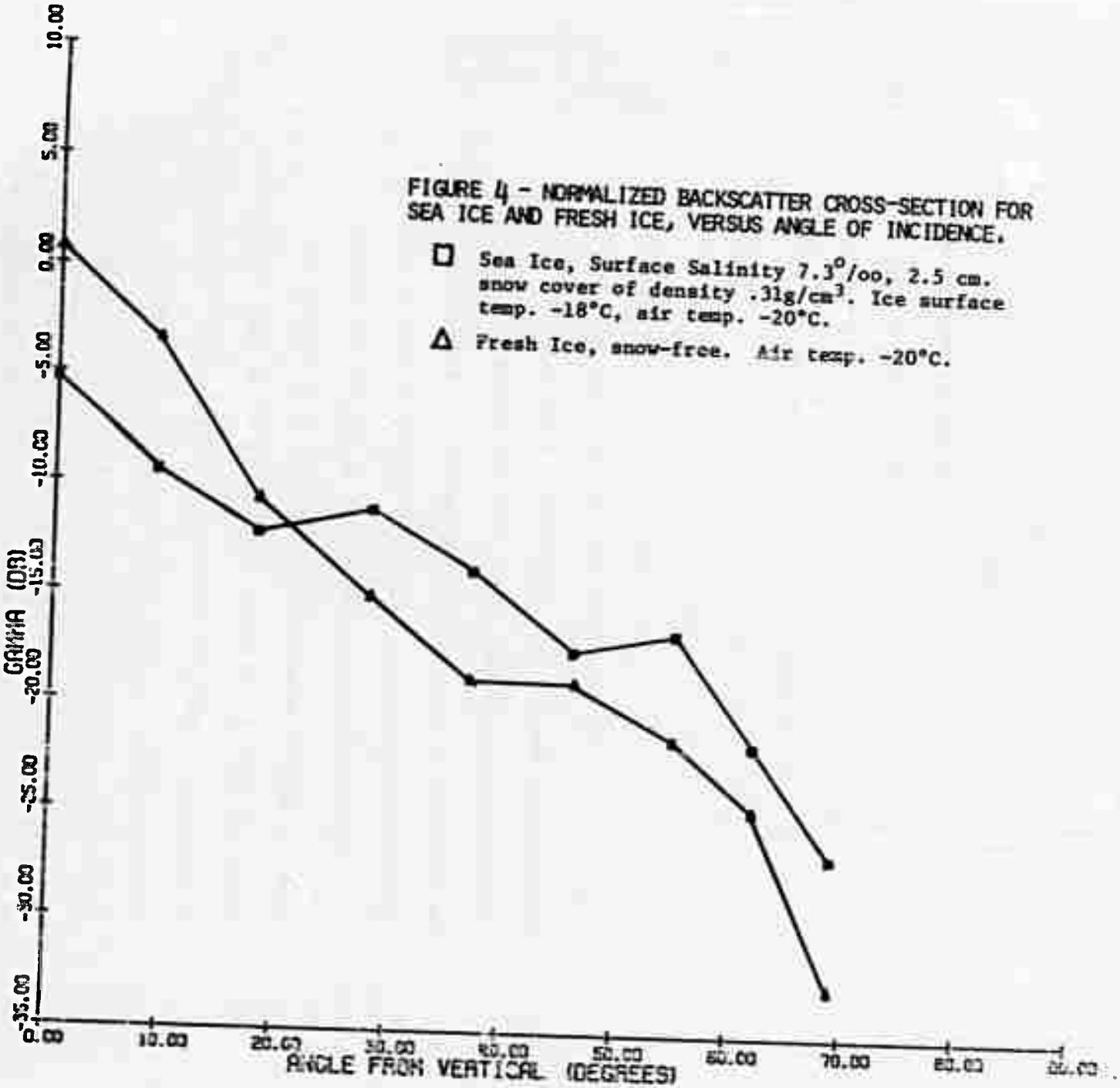


FIGURE 4 - NORMALIZED BACKSCATTER CROSS-SECTION FOR SEA ICE AND FRESH ICE, VERSUS ANGLE OF INCIDENCE.

□ Sea Ice, Surface Salinity 7.3°/oo, 2.5 cm. snow cover of density .31g/cm^3. Ice surface temp. -18°C, air temp. -20°C.

△ Fresh Ice, snow-free. Air temp. -20°C.

backscattering, so that a significant portion of the incident wave is scattered in all directions. At grazing angles of incidence, this surface roughness similarly serves to provide specular backscattering from the sea ice, whereas the smooth fresh ice gives a very low return.

In Figure 5, the normalized backscattering cross-section γ is shown for three different depths of snow cover over sea ice (2.5 cm, 8.0 cm, 40.0 cm). The general effect of increasing snow cover is to increase γ throughout most of the range of incidence angles. The difference between wet and dry snow over lake ice is shown in Figure 6. A 10 db difference at normal incidence is noted, with much less contrast at other angles. However, in Figure 7 the moisture content of the snow over frozen ground results in a considerably different angular dependence of γ in the two cases. This may be due to interference effects in the multiple snow layers, and also perhaps to resonant cell scattering from large depth-hoar snow crystals.

The results mentioned above are representative summary plots of some 53 separate groups of data taken during the winter of 1971-72. Computer tabulations of the data, together with plots of normalized backscatter cross-section γ, are given in the Appendix. In each case, the concurrent conditions of snow density, depth, and temperature profiles were taken and are also tabulated. Time limitations required postponement of detailed theoretical calculations; however, the data as

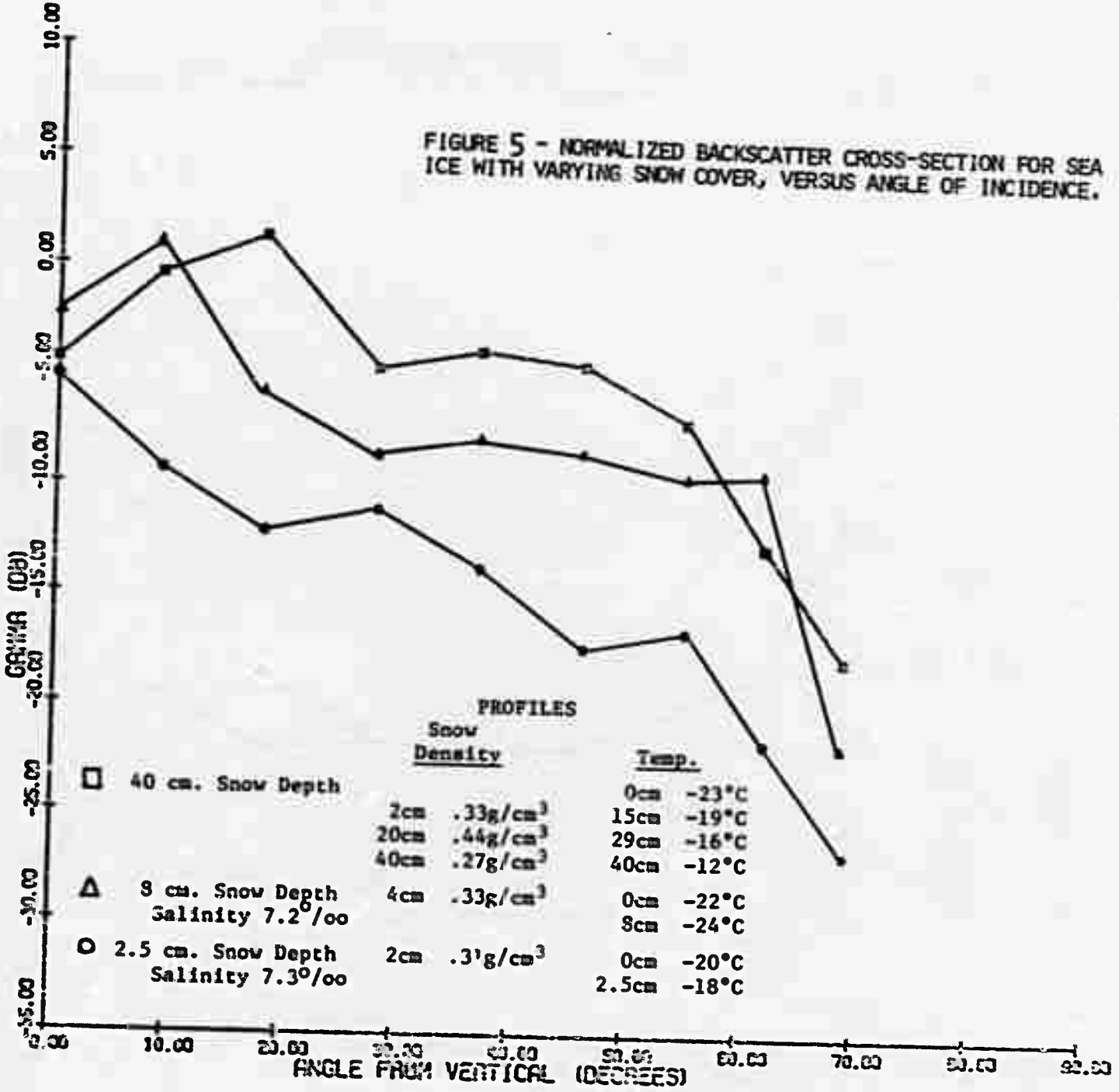


FIGURE 5 - NORMALIZED BACKSCATTER CROSS-SECTION FOR SEA ICE WITH VARYING SNOW COVER, VERSUS ANGLE OF INCIDENCE.

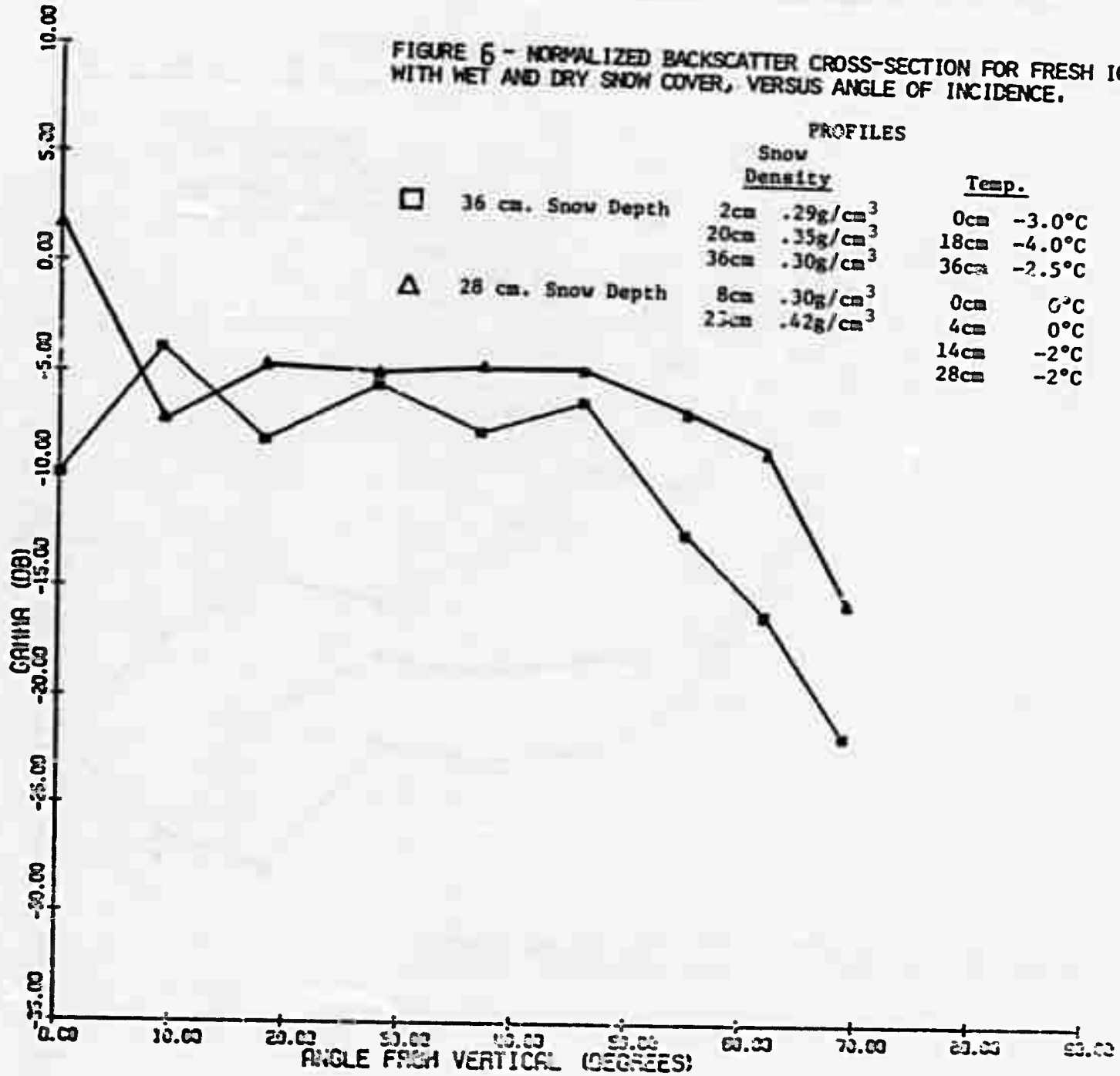
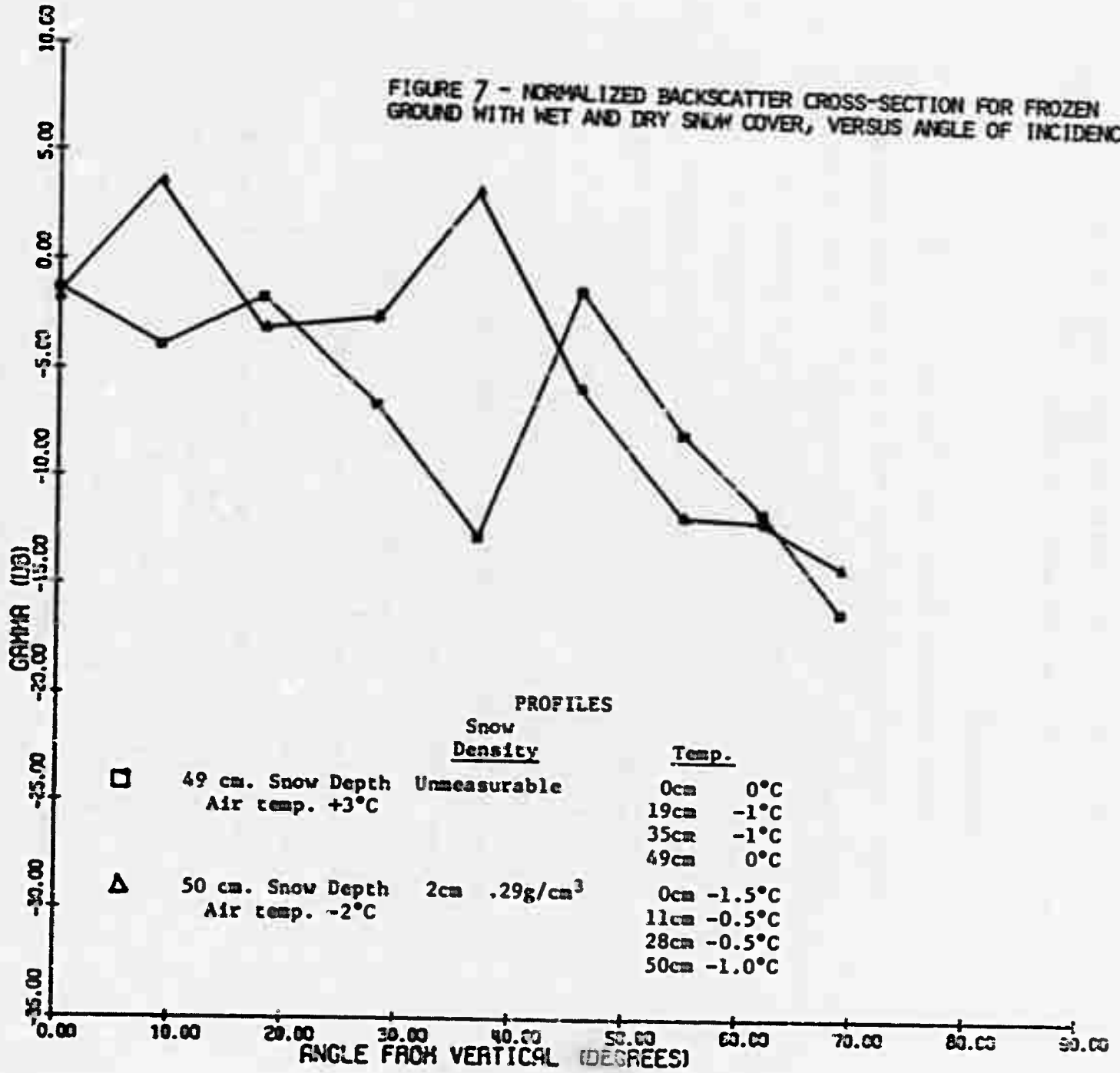


FIGURE 6 - NORMALIZED BACKSCATTER CROSS-SECTION FOR FRESH ICE WITH WET AND DRY SNOW COVER, VERSUS ANGLE OF INCIDENCE.
PROFILES
Snow Density
Temp.
36 cm. Snow Depth
2cm .29g/cm3
20cm .35g/cm3
36cm .30g/cm3
0cm -3.0°C
18cm -4.0°C
36cm -2.5°C
28 cm. Snow Depth
8cm .30g/cm3
28cm .42g/cm3
0cm 0°C
4cm 0°C
14cm -2°C
28cm -2°C
GAMMA (DB)
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
ANGLE FROM VERTICAL (DEGREES)

FIGURE 7 - NORMALIZED BACKSCATTER CROSS-SECTION FOR FROZEN GROUND WITH WET AND DRY SNOW COVER, VERSUS ANGLE OF INCIDENCE.



presented serves as a useful guide for radar system designers, and may eventually be correlated with theory.

III. CONCLUSIONS

Several conclusions may be drawn from these preliminary results. It appears to be extremely difficult to establish details about snow temperature, density, and morphology from radar backscatter information because of a wide variation in backscatter coefficient with angle. It is quite likely that multiple reflections in snow layers and the scattering from large resonant cells near the surface of the ground are the causes of this unpredictable behavior. Particularly near the melting point, there may be a drastic variation in backscatter coefficient from snow, due to the presence of large quantities of liquid water. The laboratory measurements and the field measurements for sea ice both indicate that the penetration of millimeter waves is very small and that surface topography should be readily detectable. It may also be possible to detect surface salinity variations such as those associated with the contrast between annual sea ice and multiyear sea ice. Direct confirmation of this has been made by an imaging radiometer of wavelength 1.55 cm aboard the NASA CV-990 aircraft.[9] Finally, the angular dependence of γ noted in this study is, for the most part, typical of that measured on a wide variety of rough surfaces at larger wavelength.

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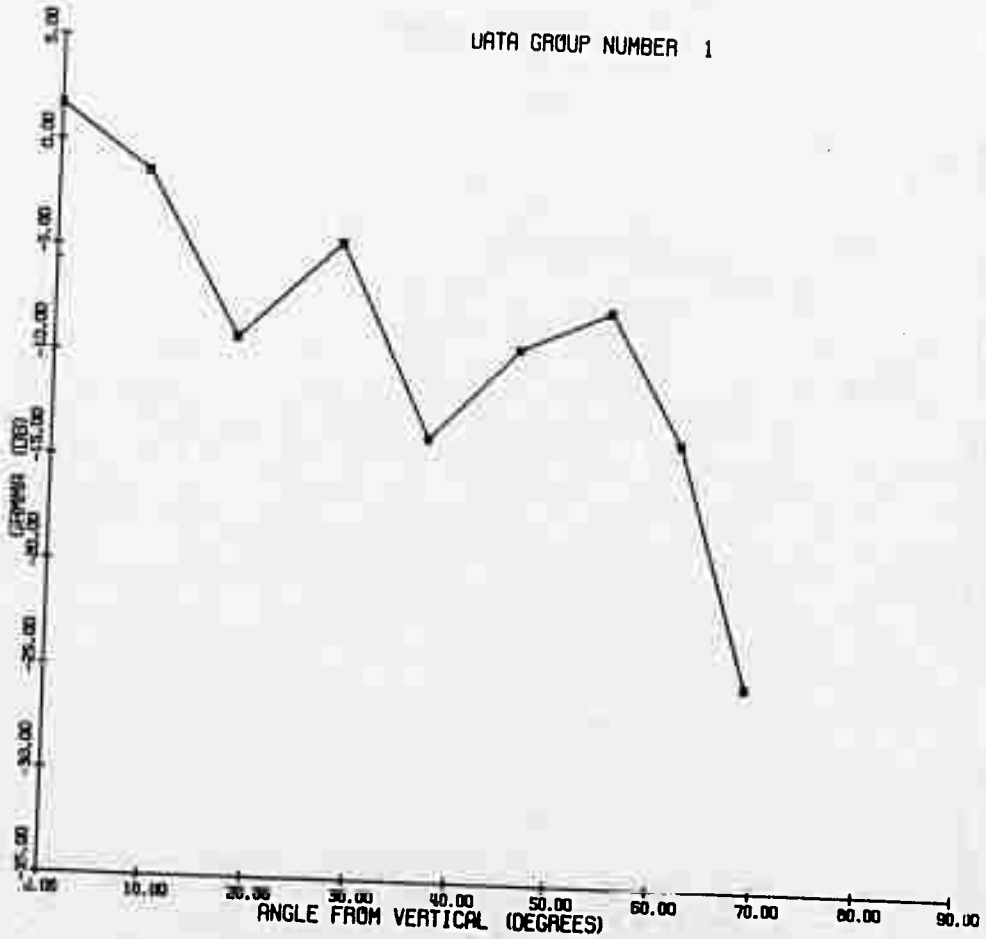
APPENDIX

In each page of the data presented, the location and date are given, together with the variation of snow density and temperature with depth. Below this data on each page is a columnar presentation of the ratio of reflected to transmitted power (in dB), a calculation of the effective angle, the equivalent area, the length of the mean ray, the normalized area, and the normalized backscatter cross-section For deep snow, two separate calculations are made for the same data; the first calculation is based upon the snow surface, and the second calculation is based upon the ground surface as a reference. These are separated into two data groups. As is mentioned above, the actual location of the scattering centers is distributed throughout the depth of the snow layer, so that these two calculations represent only the first attempts at explaining the results.

In the graphs shown, γ is plotted versus the effective incidence angle for each data group.



DATA GROUP NUMBER 1

Experimental Farm 1/11/72 Snow Density 5 .180 Temp. Prof. 4 -26.5

Air Temp. -38C (Depth in cm from) D 13 D .264 D 14 T -21.0

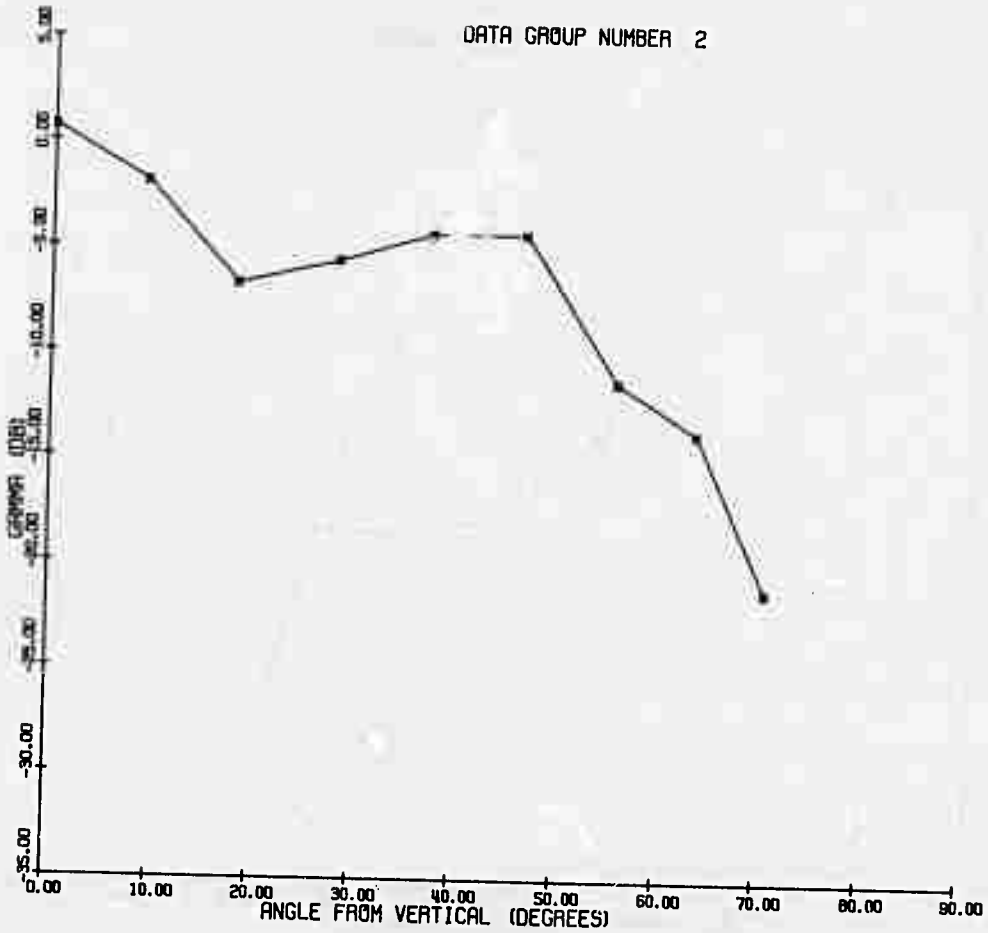
Snow Depth 58 cm (Surface) E 20 E .280 E 26 E -14.0

(Density in Gm/cm3) P 30 N .268 P 36 M - 9.0

(Temp in Degrees C) T 40 S .268 T 44 P - 7.0

Horiz. Wave -from Snow Surface H 54 . .213 H 58 . - 5.0

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-52.0	0.0	0.7958	1.83	0.538	1.4793	1.7
10.0	-55.0	9.0	0.3942	1.82	0.535	0.7371	-1.3
20.0	-62.5	18.0	0.0676	1.81	0.525	0.1287	-8.9
30.0	-57.5	28.0	0.2076	1.79	0.518	0.4011	-4.0
40.0	-66.0	37.0	0.0268	1.75	0.495	0.0542	-12.7
50.0	-60.5	46.0	0.0824	1.69	0.461	0.1789	-7.5
60.0	-57.0	55.0	0.1453	1.59	0.409	0.3555	-4.5
70.0	-60.0	62.0	0.0355	1.33	0.286	0.1244	-9.1
80.0	-65.5	69.0	0.0020	0.89	0.116	0.0169	-17.7



DATA GROUP NUMBER 2

Experimental Farm 1/11/72 Snow Density 5 .180 Temp. Prof. 4 -26.5

Air Temp. -38C (Depth in cm from) D 13 D .264 D 14 T -21.0

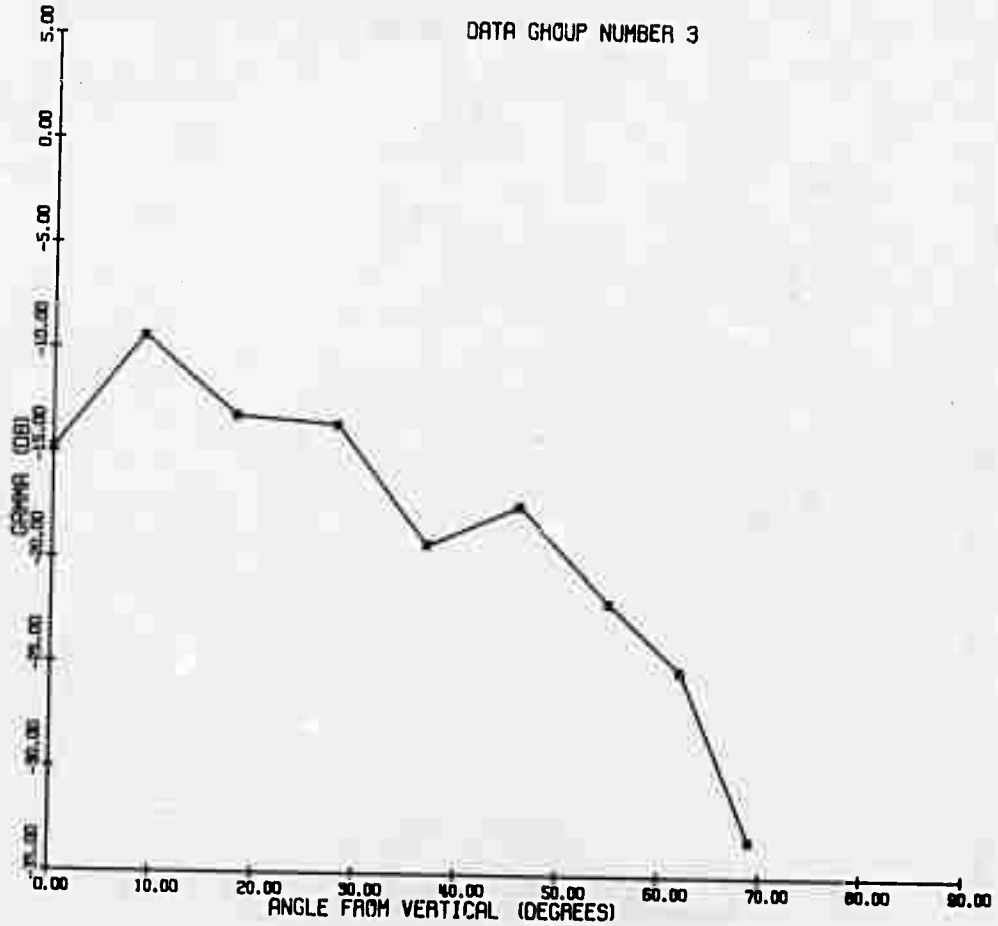
Snow Depth 58 cm (Surface) E 20 E .280 E 26 E -14.0

(Density in Gm/cm3) P 30 N .268 P 36 M - 9.0

(Temp in Degrees C) T 40 S .268 T 44 P - 7.0

Vert. Wave - from Snow Surface H 54 . .218 H 58 . - 5.0

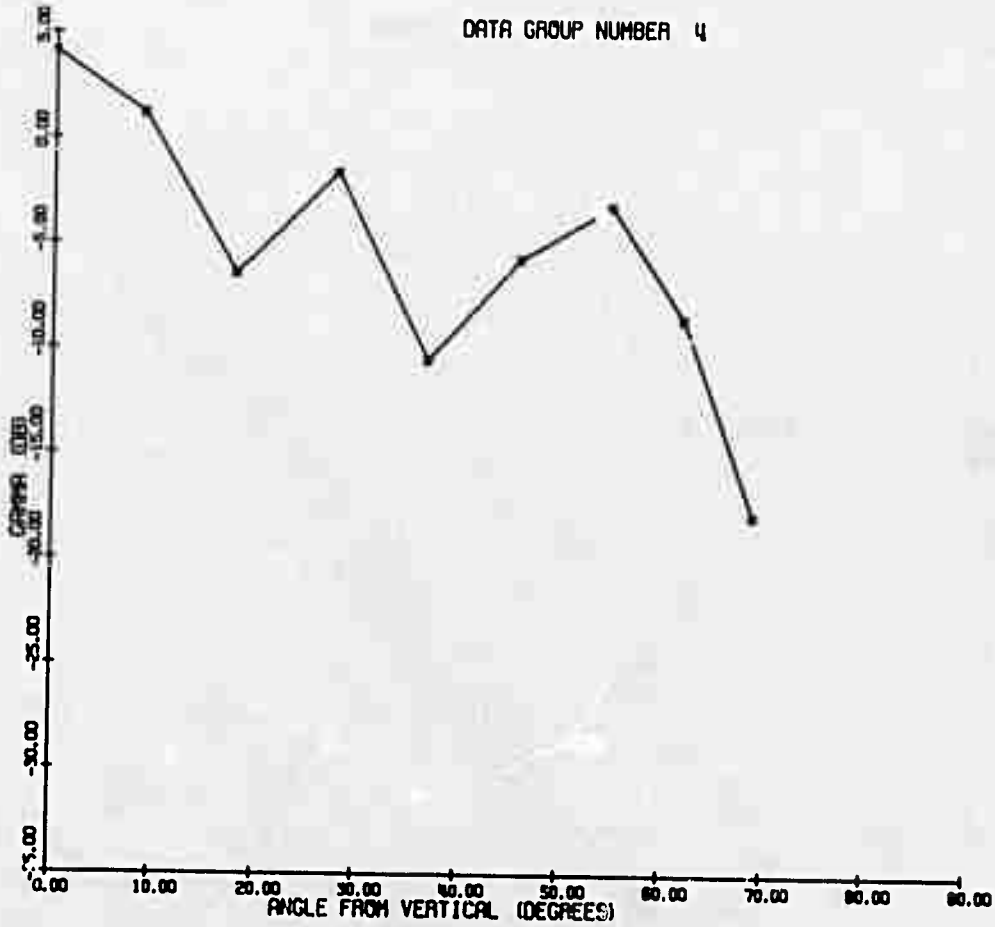
ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-53.0	0.0	0.6321	1.83	0.538	1.1751	0.7
10.0	-55.5	9.2	0.3520	1.82	0.535	0.6576	-1.8
20.0	-60.0	18.3	0.1211	1.81	0.527	0.2298	-6.4
30.0	-58.5	28.3	0.1669	1.80	0.521	0.3206	-4.9
40.0	-56.5	37.5	0.2454	1.77	0.502	0.4894	-3.1
50.0	-55.5	46.7	0.2735	1.71	0.472	0.5796	-2.4
60.0	-61.0	55.8	0.0629	1.63	0.426	0.1476	-8.3
70.0	-60.5	63.8	0.0407	1.42	0.324	0.1257	-9.0
80.0	-62.0	70.8	0.0062	0.97	0.143	0.0433	-13.6



DATA GROUP NUMBER 3

Experimental Farm 1/11/72	Snow Density 5	.180	Temp. Prof. 4	-26.5		
Air Temp. -38C	(Depth in cm from)	D 13	D .264	D 14	T -21.0	
Snow Depth 58 cm	(Surface)	E 20	E .280	E 26	E -14.0	
	(Density in Gm/cm3)	P 30	N .268	P 36	M - 9.0	
	(Temp in Degrees C)	T 40	S .268	T 44	P - 7.0	
Orth. Wave - from Snow Surface		H 54	. .218	H 58	. - 5.0	

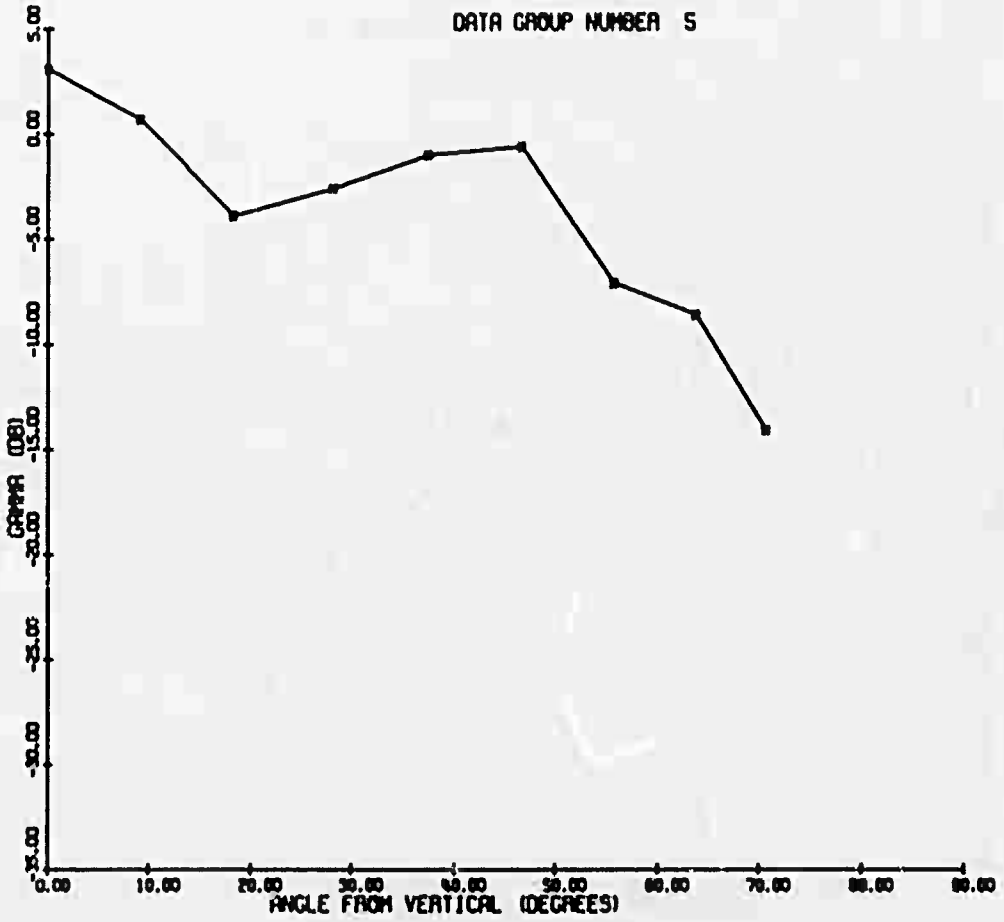
ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-68.5	0.0	0.0178	1.83	0.538	0.0331	-14.8
10.0	-63.0	9.0	0.0625	1.82	0.535	0.1168	-9.3
20.0	-66.5	18.0	0.0269	1.81	0.525	0.0512	-12.9
30.0	-66.5	28.0	0.0261	1.79	0.518	0.0505	-13.0
40.0	-71.5	37.0	0.0076	1.75	0.495	0.0153	-18.2
50.0	-68.5	46.0	0.0131	1.69	0.461	0.0284	-15.5
60.0	-71.5	55.0	0.0052	1.59	0.409	0.0126	-19.0
70.0	-71.5	62.0	0.0025	1.33	0.286	0.0088	-20.6
80.0	-73.5	69.0	0.0003	0.89	0.116	0.0027	-25.7



DATA GROUP NUMBER 4

Experimental Farm 1/11/72	Snow Density 5	.180	Temp. Prof. 4	-26.5
Air Temp. -38C	(Depth in cm from)	D 13	D .264	D 14	T -21.0
Snow Depth 58 cm	(Surface)	E 20	E .280	E 26	E -14.0
	(Density in Gm/cm3)	P 30	N .268	P 36	M - 9.0
	(Temp in Degrees C)	T 40	S .268	T 44	P - 7.0
Horiz. Wave - from Ground (NSNOW=1.22)	H 54	.218	H 58	. - 5.0

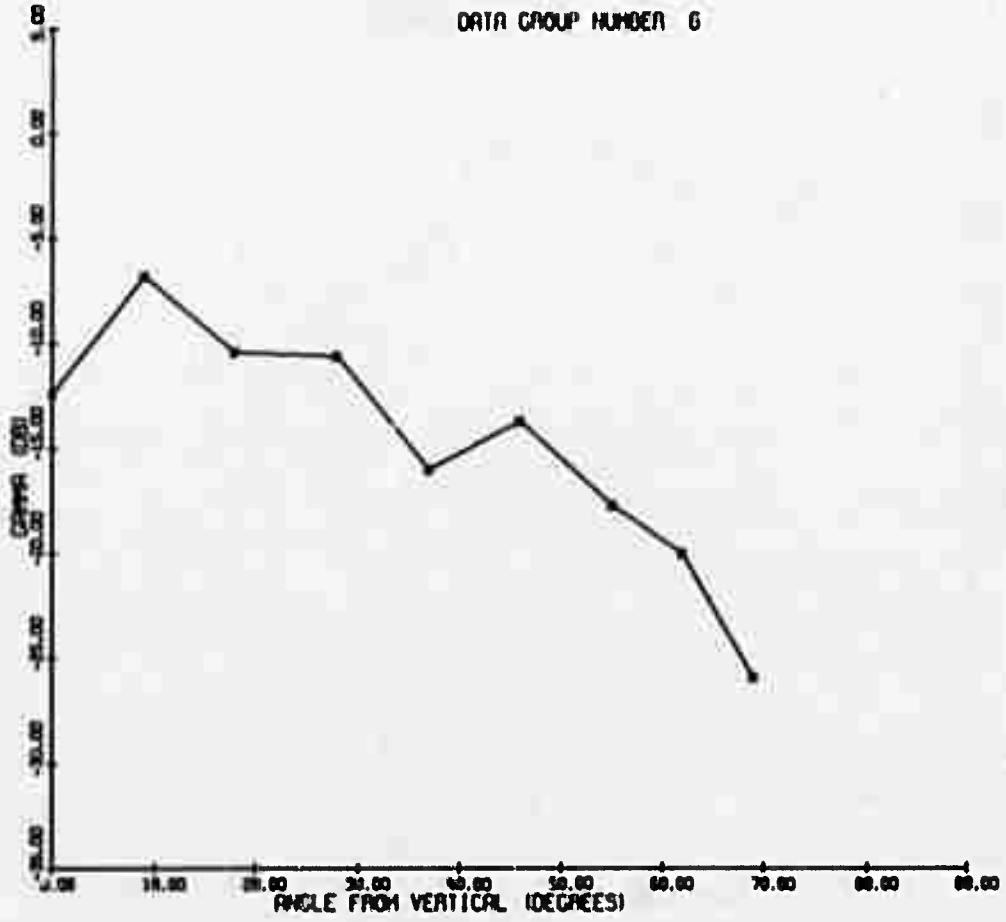
ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-52.0	0.0	2.3951	2.41	0.933	2.5665	4.1
10.0	-55.0	9.0	1.2735	2.44	0.961	1.3249	1.2
20.0	-62.5	18.0	0.2391	2.48	0.988	0.2421	-6.2
30.0	-57.5	28.0	0.8257	2.53	1.032	0.8000	-1.0
40.0	-66.0	37.0	0.1234	2.57	1.061	0.1162	-9.3
50.0	-60.5	46.0	0.4575	2.60	1.085	0.4216	-3.8
60.0	-57.0	55.0	1.0377	2.61	1.092	0.9500	-0.2
70.0	-60.0	62.0	0.3969	2.44	0.954	0.4159	-3.8
80.0	-65.5	69.0	0.0598	2.08	0.640	0.0935	-10.3



DATA GROUP NUMBER 5

Experimental Farm 1/11/72	Snow Density	5	.180	Temp. Prof.	4		-26.5
Air Temp. -38C	(Depth in cm from)	D 13	D .264		D 14	T	-21.0
Snow Depth 58 cm	(Surface)	E 20	E .280		E 26	E	-14.0
	(Density in Gm/cm3)	P 30	N .268		P 36	H	- 9.0
	(Temp in Degrees C)	T 40	S .268		T 44	P	- 7.0
Vert. Wave -from Ground (NSNOW=1.22)		H 54	. .218		H 58	.	- 5.0

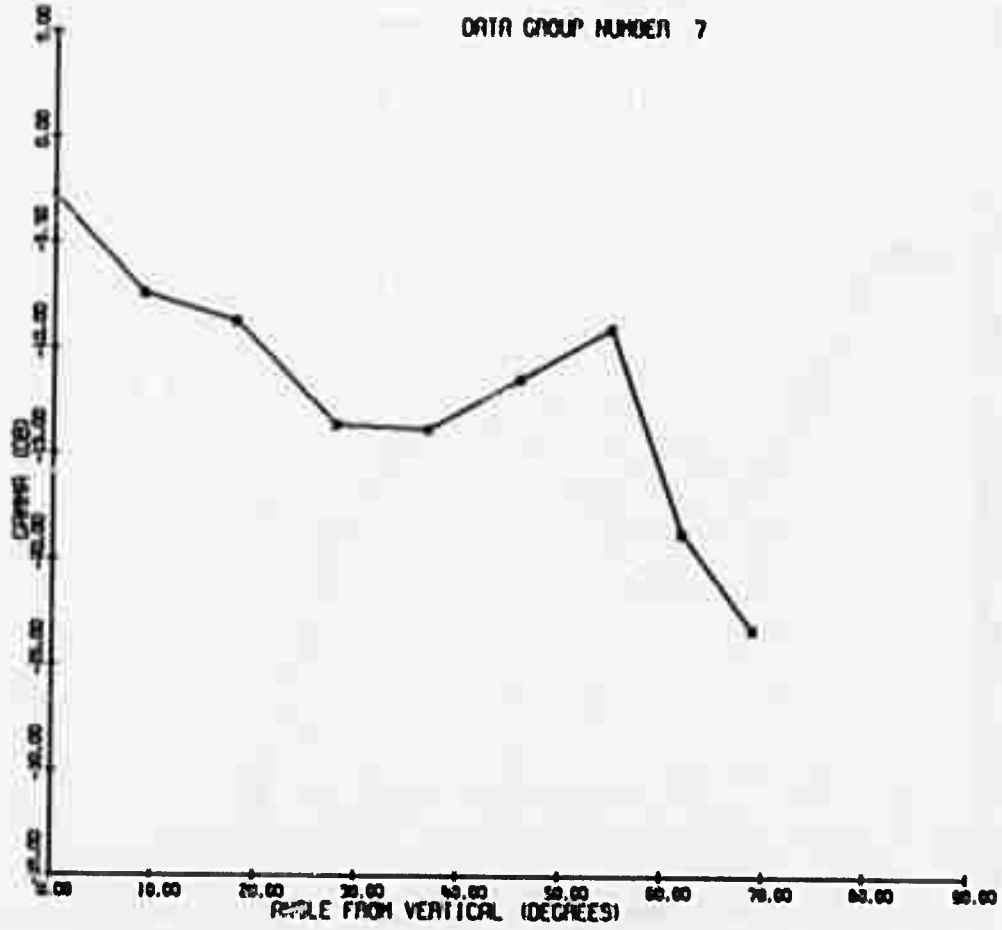
ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-53.0	0.0	1.9025	2.41	0.933	2.0386	3.1
10.0	-55.5	9.2	1.1382	2.45	0.963	1.1825	0.7
20.0	-60.0	18.3	0.4290	2.48	0.992	0.4324	-3.6
30.0	-58.5	28.3	0.6643	2.54	1.039	0.6395	-1.9
40.0	-56.5	37.5	1.1276	2.59	1.075	1.0489	0.2
50.0	-55.5	46.7	1.5099	2.63	1.109	1.3619	1.3
60.0	-61.0	55.8	0.4420	2.65	1.130	0.3912	-4.1
70.0	-60.5	63.8	0.4224	2.55	1.043	0.4051	-3.9
80.0	-62.0	70.8	0.1628	2.19	0.734	0.2217	-6.5



DATA GROUP NUMBER 6

Experimental Farm 1/11/72	Snow Density 5	.180	Temp. Prof. 4	-26.5
Air Temp. -38C	(Depth in cm from)	D 13	D .264	D 14	T -21.0
Snow Depth 58 cm	(Surface)	E 20	E .280	E 26	E -14.0
	(Density in Gm/cm3)	P 30	M .268	P 36	M - 9.0
	(Temp in Degrees C)	T 40	S .268	T 44	P - 7.0
Orth. Wave -from Ground (NSNOW=1.22)		H 54	. .218	H 58	. - 5.0

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-68.5	0.0	0.0536	2.41	0.933	0.0575	-12.4
10.0	-63.0	9.0	0.2018	2.44	0.961	0.2100	-6.8
20.0	-66.5	18.0	0.0952	2.48	0.988	0.0964	-10.2
30.0	-66.5	28.0	0.1039	2.53	1.032	0.1007	-10.0
40.0	-71.5	37.0	0.0348	2.57	1.061	0.0328	-14.8
50.0	-68.5	46.0	0.0725	2.60	1.085	0.0668	-11.8
60.0	-71.5	55.0	0.0368	2.61	1.092	0.0337	-14.7
70.0	-71.5	62.0	0.0281	2.44	0.954	0.0294	-15.3
80.0	-73.5	69.0	0.0095	2.08	0.640	0.0148	-18.3



DATA GROUP NUMBER 7

Pt. Barrow Sea Ice 1/18/72 Moderately Rough Surface

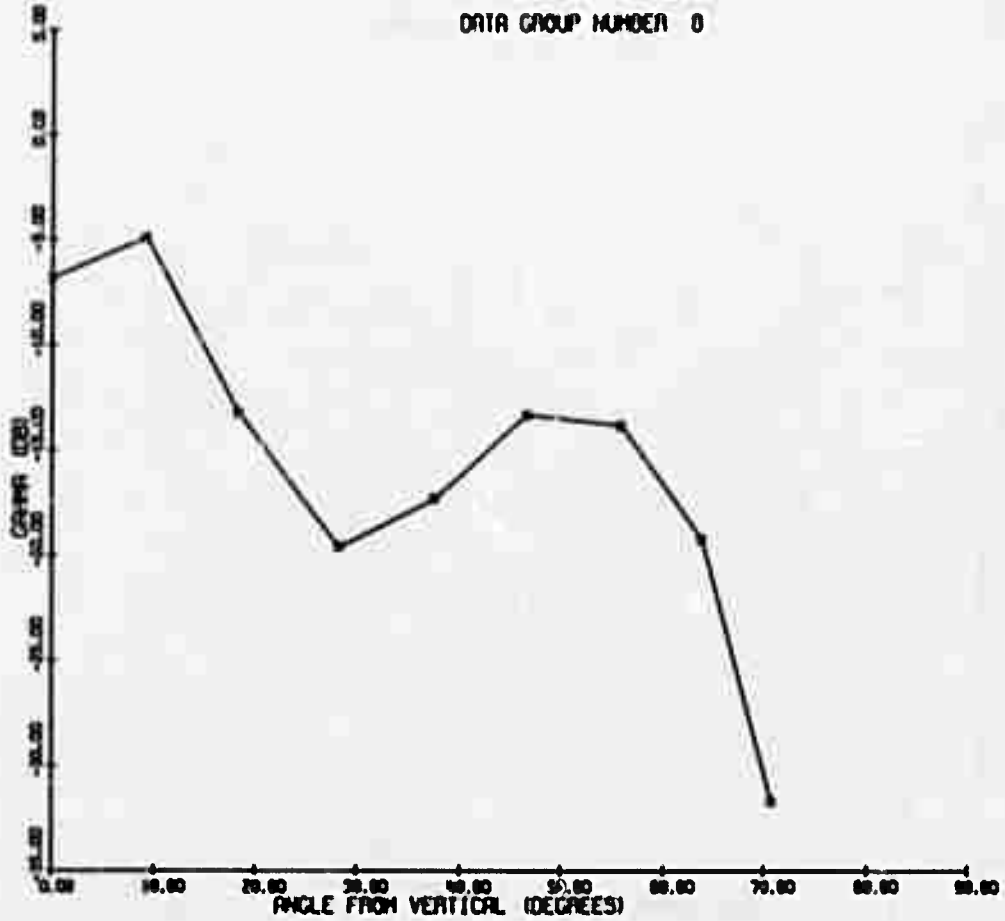
Avg. Surface Sal. 9.4 PPT

Air Temp. -11C Snow Density Surface .060 Temp Profile Surface -11.0C

Snow Depth 17 cm, 2 cm New Wind Pack .384 17 cm -14.0C

Horiz. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-56.5	0.0	0.2824	1.83	0.538	0.5249	-2.8
10.0	-61.0	9.0	0.0990	1.82	0.535	0.1852	-7.3
20.0	-62.0	18.0	0.0758	1.81	0.525	0.1444	-8.4
30.0	-66.5	28.0	0.0261	1.79	0.518	0.0505	-13.0
40.0	-66.0	37.0	0.0268	1.75	0.495	0.0542	-12.7
50.0	-62.5	46.0	0.0520	1.69	0.461	0.1129	-9.5
60.0	-58.5	55.0	0.1029	1.59	0.409	0.2517	-6.0
70.0	-65.0	62.0	0.0112	1.33	0.286	0.0394	-14.1
80.0	-63.5	69.0	0.0031	0.89	0.116	0.0268	-15.7



DATA GROUP NUMBER 8

Pt. Barrow Sea Ice 1/18/72 Moderately Rough Surface

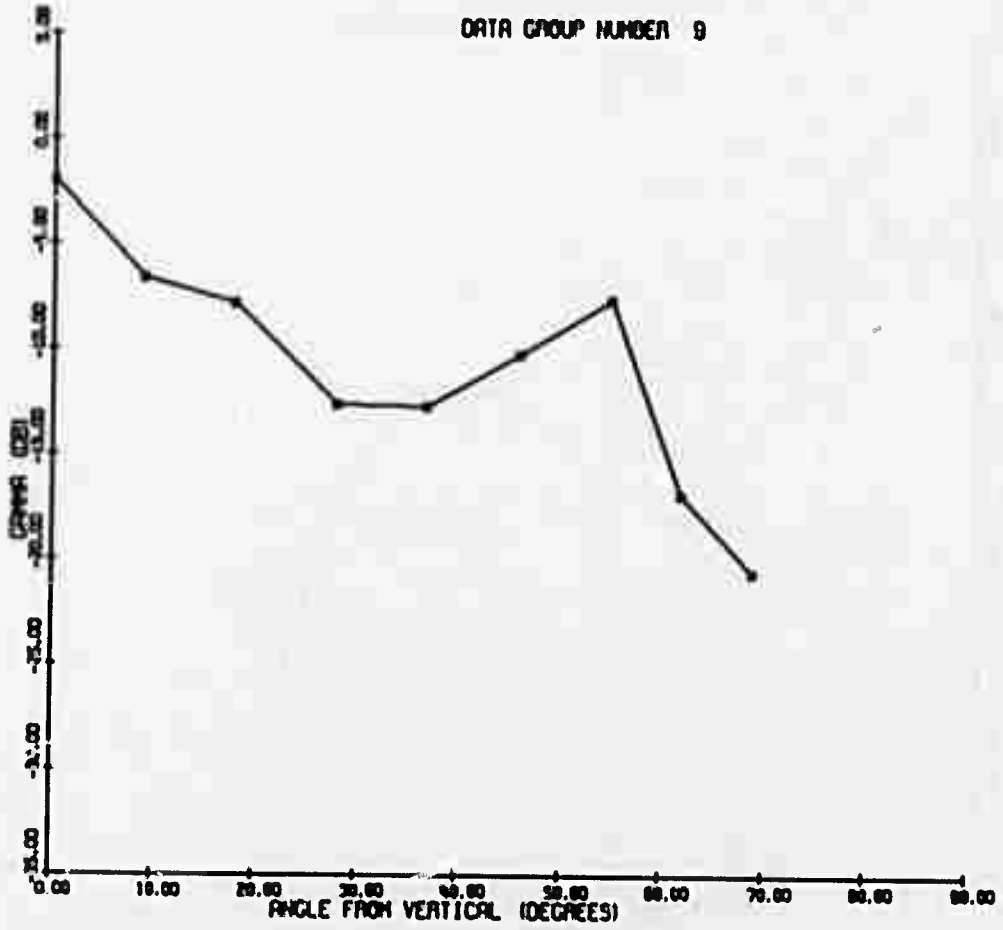
Avg. Surface Sal. 9.4 PPT

Air Temp. -11C Snow Density Surface .060 Temp Profile Surface -1[illegible].0C

Snow Depth 17 cm, 2 cm New Wind Pack .384 17 cm -14.0C

Vert. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-60.5	0.0	0.1124	1.83	0.538	0.2090	-6.8
10.0	-58.5	9.2	0.1764	1.82	0.535	0.3296	-4.8
20.0	-66.5	18.3	0.0271	1.81	0.527	0.0514	-12.9
30.0	-72.5	28.3	0.0066	1.80	0.521	0.0128	-18.9
40.0	-69.5	37.5	0.0123	1.77	0.502	0.0245	-16.1
50.0	-64.5	46.7	0.0344	1.71	0.472	0.0730	-11.4
60.0	-63.5	55.8	0.0354	1.63	0.426	0.0830	-10.8
70.0	-66.0	63.8	0.0115	1.42	0.324	0.0354	-14.5
80.0	-72.5	70.8	0.0006	0.97	0.143	0.0039	-24.1



DATA GROUP NUMBER 9

Pt. Barrow Sea Ice 1/18/72 Moderately Rough Surface

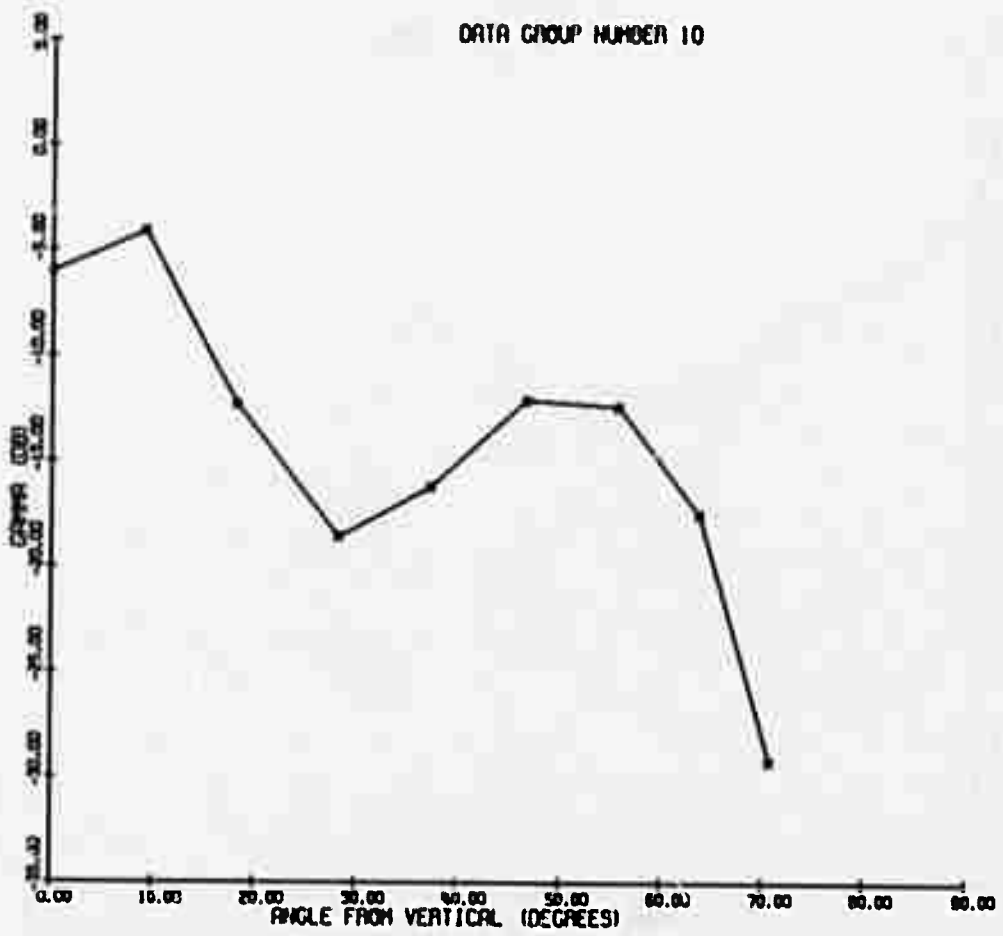
Avg. Surface Sal. 9.4 PPT

Air Temp. -11C Snow Density Surface .060 Temp. Profile Surface -11.0C

Snow Depth 17 cm, 2 cm New Wind Pack .384 17 cm -14.0C

Horiz. Wave -from Ice Surface (NSNOW=1.30)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-56.5	0.0	0.4029	2.00	0.643	0.6270	-2.0
10.0	-61.0	9.0	0.1447	2.00	0.646	0.2238	-6.5
20.0	-62.0	18.0	0.1142	2.00	0.644	0.1772	-7.5
30.0	-66.5	28.0	0.0409	2.01	0.648	0.0632	-12.0
40.0	-66.0	37.0	0.0441	1.99	0.634	0.0595	-11.6
50.0	-62.5	46.0	0.0910	1.95	0.609	0.1494	-8.3
60.0	-58.5	55.0	0.1963	1.87	0.565	0.3477	-4.6
70.0	-65.0	62.0	0.0253	1.63	0.429	0.0591	-12.3
80.0	-63.5	69.0	0.0107	1.21	0.215	0.0497	-13.0



DATA GROUP NUMBER 10

Pt. Barrow Sea Ice 1/18/72 Moderately Rough Surface

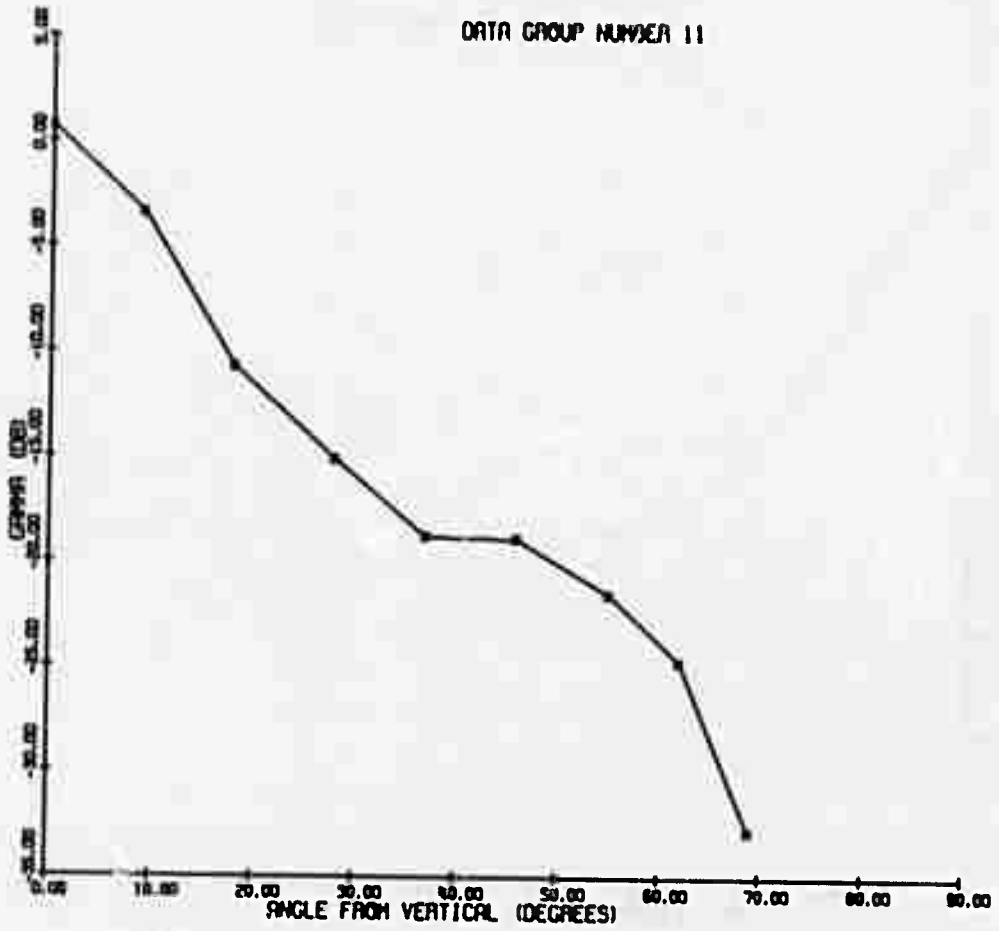
Avg. Surface Sal. 9.4 PPT

Air Temp. -11C Snow Density Surface .060 Temp. Profile Surface -11.0C

Snow Depth 17 cm, 2 cm New Wind Pack .384 17 cm -14.0C

Vert. Wave -from Ice Surface (NSNOW=1.30)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-60.5	0.0	0.1604	2.00	0.643	0.2496	-6.0
10.0	-58.5	9.2	0.2578	2.01	0.647	0.3984	-4.0
20.0	-66.5	18.3	0.0408	2.01	0.647	0.0631	-12.0
30.0	-72.5	28.3	0.0104	2.01	0.652	0.0160	-18.0
40.0	-69.5	37.5	0.0202	2.00	0.643	0.0314	-15.0
50.0	-64.5	46.7	0.0601	1.97	0.624	0.0964	-10.2
60.0	-63.5	55.8	0.0670	1.91	0.587	0.1142	-9.4
70.0	-66.0	63.8	0.0250	1.72	0.478	0.0523	-12.8
80.0	-72.5	70.8	0.0018	1.29	0.256	0.0069	-21.6



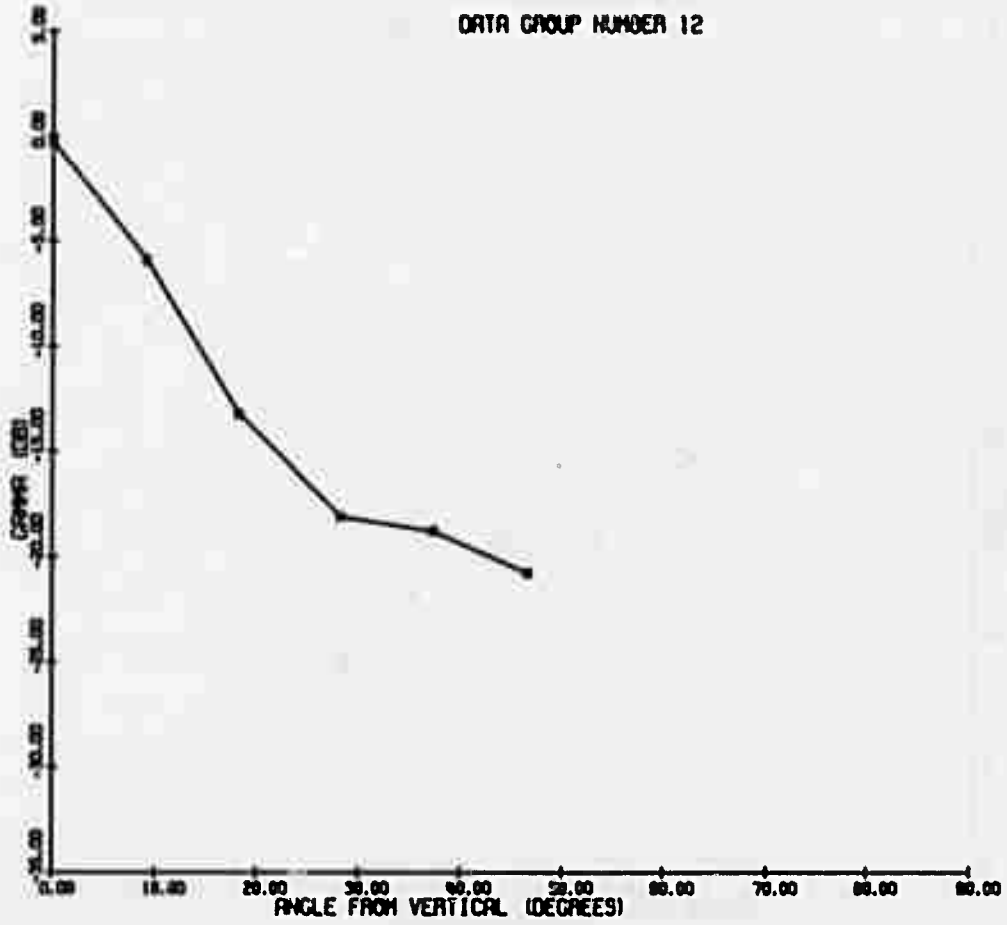
DATA GROUP NUMBER 11

Pt. Barrow Fresh Water, Lake Ice 1/19/72 Smooth Surface

No Snow Cover Air Temp. -21C

Horiz. Wave -from Ice Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-53.0	0.0	0.6321	1.83	0.538	1.1751	0.7
10.0	-57.0	9.0	0.2487	1.82	0.535	0.4651	-3.3
20.0	-64.0	18.0	0.0479	1.81	0.525	0.0911	-10.4
30.0	-68.0	28.0	0.0185	1.79	0.518	0.0357	-14.5
40.0	-71.0	37.0	0.0085	1.75	0.495	0.0171	-17.7
50.0	-70.0	46.0	0.0092	1.69	0.461	0.0201	-17.0
60.0	-71.0	55.0	0.0058	1.59	0.409	0.0142	-18.5
70.0	-71.0	62.0	0.0028	1.33	0.286	0.0099	-20.1
80.0	-73.0	69.0	0.0003	0.89	0.116	0.0030	-25.2



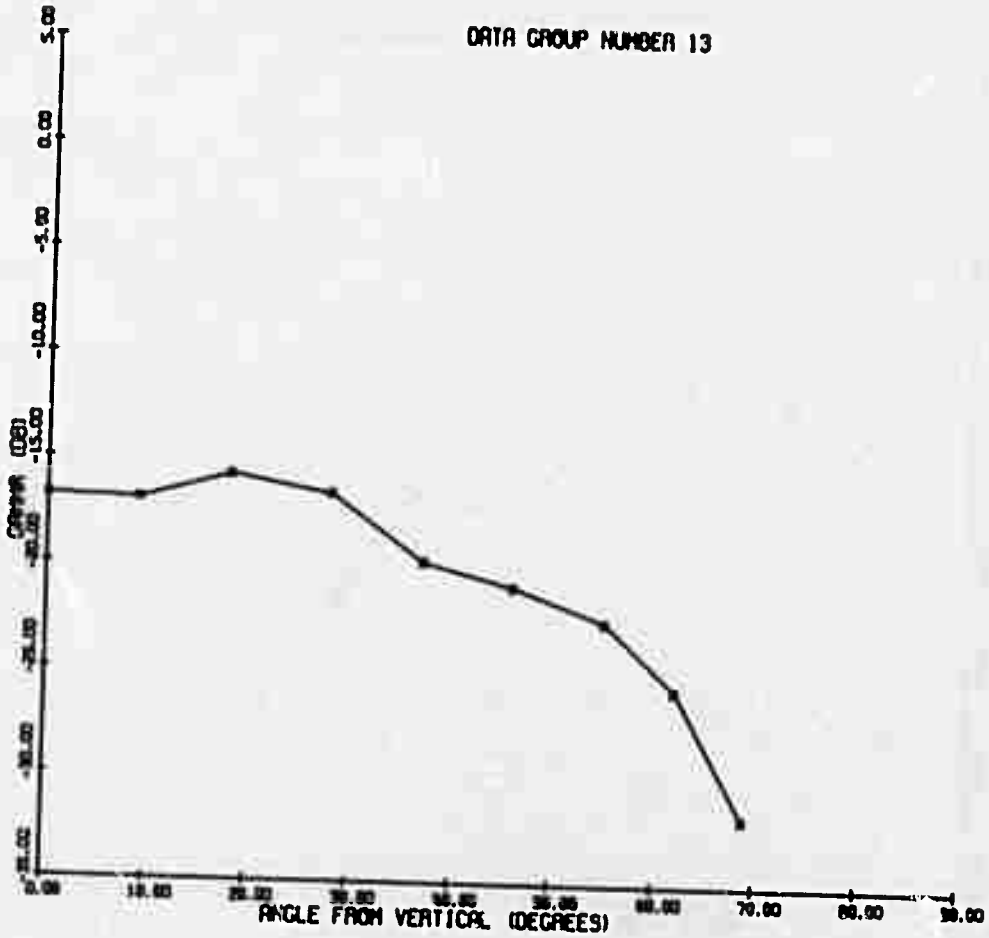
DATA GROUP NUMBER 12

Pt Barrow Fresh Water, Lake Ice 1/19/72 Smooth Surface

No Snow Cover Air Temp. -21C

Vert. Wave -from Ice Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-54.0	0.0	0.5021	1.83	0.538	0.9334	-0.3
10.0	-59.5	9.2	0.1401	1.82	0.535	0.2618	-5.8
20.0	-66.5	18.3	0.0271	1.81	0.527	0.0514	-12.9
30.0	-71.0	28.3	0.0094	1.80	0.521	0.0180	-17.4
40.0	-71.0	37.5	0.0087	1.77	0.502	0.0174	-17.6
50.0	-72.0	46.7	0.0061	1.71	0.472	0.0130	-18.9
60.0	NO RETURN						
70.0	NO RETURN						
80.0	NO RETURN						



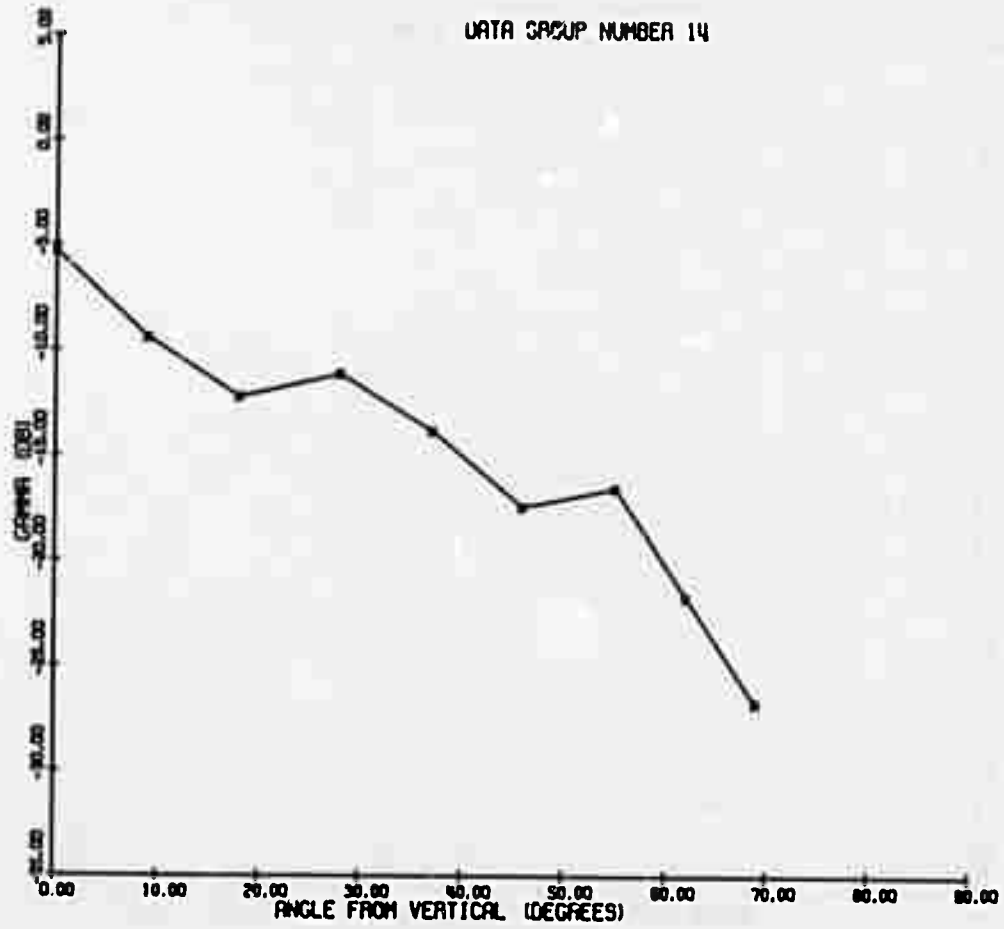
DATA GROUP NUMBER 13

Pt. Barrow Fresh Water, Lake Ice 1/19/72 Smooth Surface

No Snow Cover Air Temp. -21C

Orth. Wave -from Ice Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-70.5	0.0	0.0112	1.83	0.538	0.0209	-16.8
10.0	-70.5	9.0	0.0111	1.82	0.535	0.0208	-16.8
20.0	-69.0	18.0	0.0151	1.81	0.525	0.0288	-15.4
30.0	-69.5	28.0	0.0131	1.79	0.518	0.0253	-16.0
40.0	-72.0	37.0	0.0067	1.75	0.495	0.0136	-18.7
50.0	-72.0	46.0	0.0058	1.69	0.467	0.0127	-19.0
60.0	-72.0	55.0	0.0046	1.59	0.409	0.0112	-19.5
70.0	-72.0	62.0	0.0022	1.33	0.286	0.0079	-21.1
80.0	-72.0	69.0	0.0004	0.89	0.116	0.0038	-24.2



DATA GROUP NUMBER 14

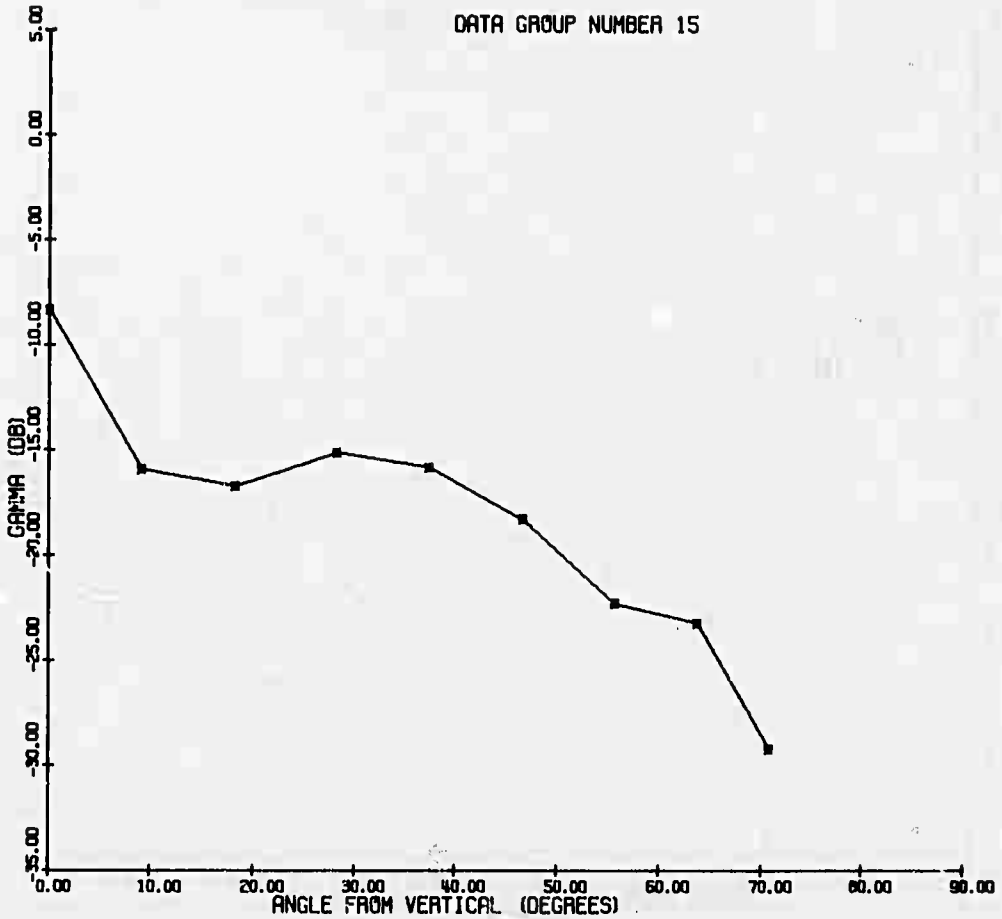
Pt. Barrow Sea Ice, Elson Lagoon 1/20/72 Moderately Smooth

Air Temp. -20C Snow Density 0.308 Salinity 7.3 PPT

Snow Depth 2.5 cm, Wind Pack Ice Surf. Temp. -18.0C

Horiz. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-59.0	0.0	0.1588	1.83	0.538	0.2952	-5.3
10.0	-63.0	9.0	0.0625	1.82	0.535	0.1168	-9.3
20.0	-65.5	18.0	0.0339	1.81	0.525	0.0645	-11.9
30.0	-64.0	28.0	0.0465	1.79	0.518	0.0898	-10.5
40.0	-66.0	37.0	0.0268	1.75	0.495	0.0542	-12.7
50.0	-68.5	46.0	0.0131	1.69	0.461	0.0284	-15.5
60.0	-66.0	55.0	0.0183	1.59	0.409	0.0448	-13.5
70.0	-68.0	62.0	0.0056	1.33	0.286	0.0197	-17.1
80.0	-67.0	69.0	0.0014	0.89	0.116	0.0120	-19.2



DATA GROUP NUMBER 15

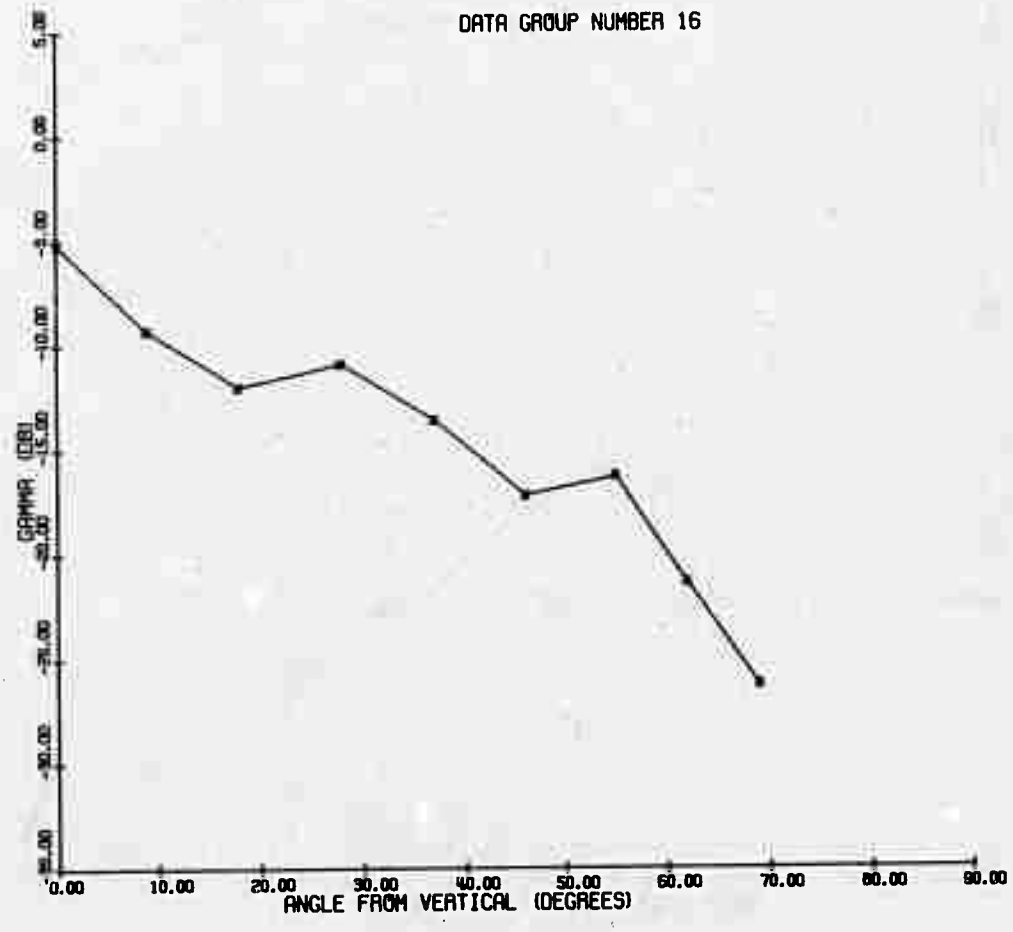
Pt. Barrow Sea Ice, Elson Lagoon 1/20/72 Moderately Smooth

Air Temp. -20C Snow Density 0.308 Salinity 7.3 PPT

Snow Depth 2.5 cm, Wind Pack Ice Surf. Temp. -18.0C

Vert. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-62.0	0.0	0.0796	1.83	0.538	0.1479	-8.3
10.0	-69.5	9.2	0.0140	1.82	0.535	0.0262	-15.8
20.0	-70.0	18.3	0.0121	1.81	0.527	0.0230	-16.4
30.0	-68.0	28.3	0.0187	1.80	0.521	0.0360	-14.4
40.0	-68.0	37.5	0.0174	1.77	0.502	0.0346	-14.6
50.0	-69.5	46.7	0.0109	1.71	0.472	0.0231	-16.4
60.0	-72.0	55.8	0.0050	1.63	0.426	0.0117	-19.3
70.0	-70.0	63.8	0.0046	1.42	0.324	0.0141	-18.5
80.0	-70.0	70.8	0.0010	0.97	0.143	0.0069	-21.6



DATA GROUP NUMBER 16

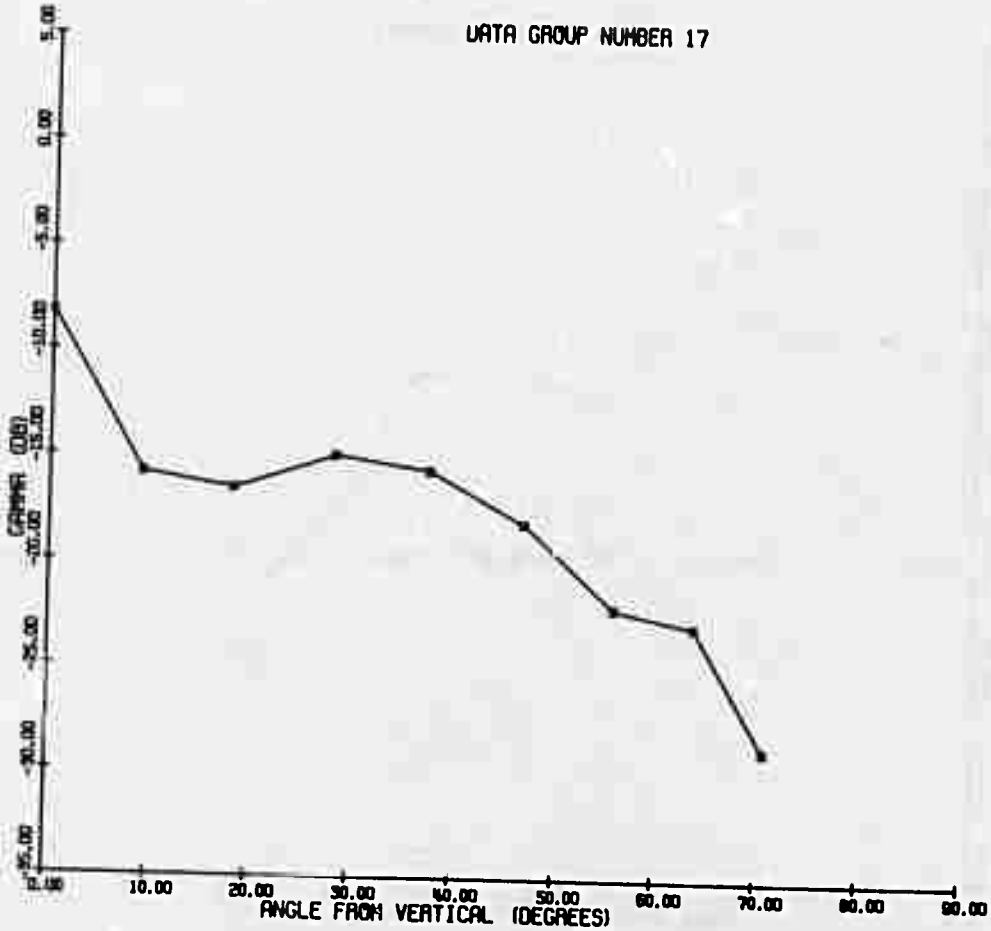
Pt. Barrow Sea Ice, Elson Lagoon 1/20/72 Moderately Smooth

Air Temp. -20C Snow Density 0.308 Salinity 7.3 PPT

Snow Depth 2.5 cm, Wind Pack Ice Surf. Temp. -18.0C

Horiz. Wave -from Ice Surface (NSNOW=1.26)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-59.0	0.0	0.1676	1.85	0.553	0.3033	-5.2
10.0	-63.0	9.0	0.0662	1.85	0.551	0.1203	-9.2
20.0	-65.5	18.0	0.0361	1.84	0.542	0.0666	-11.8
30.0	-64.0	28.0	0.0498	1.83	0.536	0.0930	-10.3
40.0	-66.0	37.0	0.0290	1.79	0.515	0.0563	-12.5
50.0	-68.5	46.0	0.0143	1.73	0.482	0.0297	-15.3
60.0	-66.0	55.0	0.0203	1.64	0.431	0.0472	-13.3
70.0	-68.0	62.0	0.0064	1.38	0.305	0.0211	-16.8
80.0	-67.0	69.0	0.0017	0.94	0.129	0.0133	-18.7



DATA GROUP NUMBER 17

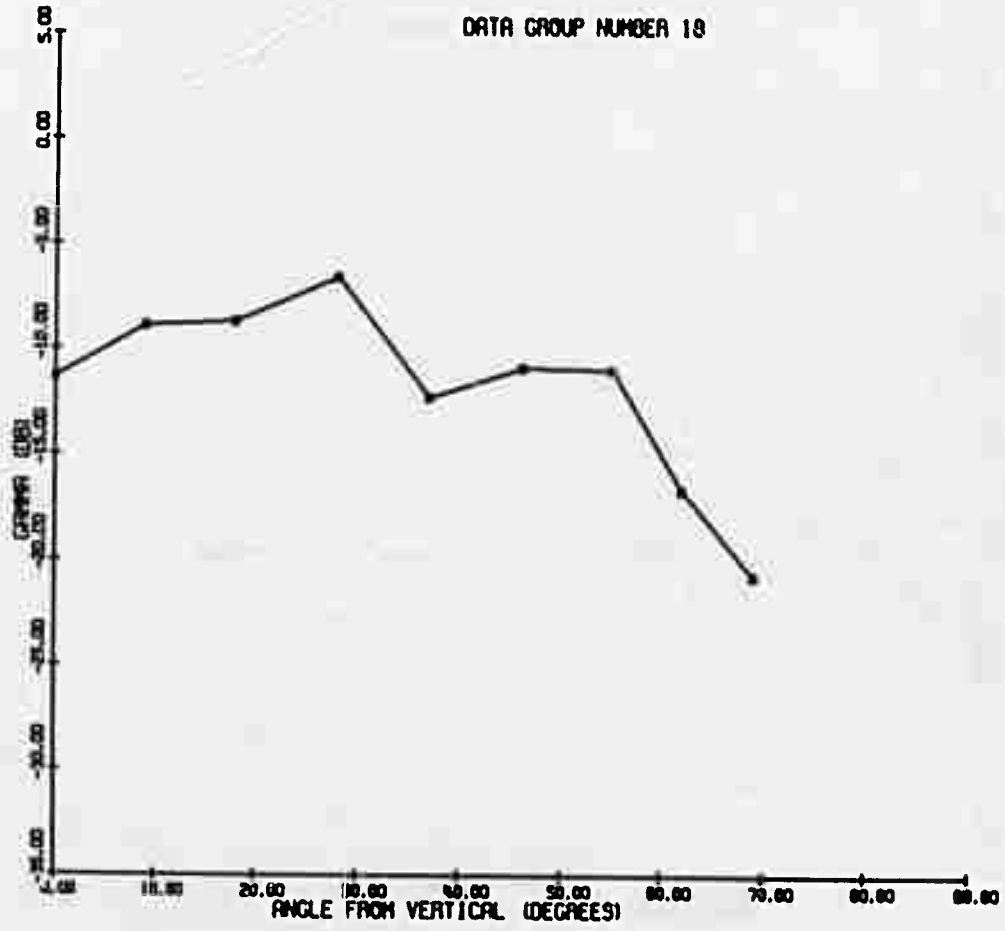
Pt. Barrow Sea Ice, Elson Lagoon 1/20/72 Moderately Smooth

Air Temp. -20C Snow Density 0.308 Salinity 7.3 PPT

Snow Depth 2.5 cm, Wind Pack Ice Surf. Temp. -18.0C

Vert. Wave -from Ice Surface (NSNOW=1.26)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-62.0	0.0	0.0840	1.85	0.553	0.1520	-8.2
10.0	-69.5	9.2	0.0149	1.85	0.551	0.0270	-15.7
20.0	-70.0	18.3	0.0129	1.84	0.544	0.0237	-16.2
30.0	-68.0	28.3	0.0201	1.83	0.539	0.0372	-14.3
40.0	-68.0	37.5	0.0188	1.80	0.521	0.0360	-14.4
50.0	-69.5	46.7	0.0119	1.75	0.493	0.0241	-16.2
60.0	-72.0	55.8	0.0055	1.67	0.449	0.0123	-19.1
70.0	-70.0	63.8	0.0052	1.46	0.345	0.0150	-18.2
80.0	-70.0	70.8	0.0012	1.02	0.159	0.0076	-21.2



DATA GROUP NUMBER 18

Pt. Barrow, Rough Sea Ice (Rubble) 1/21/72 Avg. Salinity 3.5 PPT

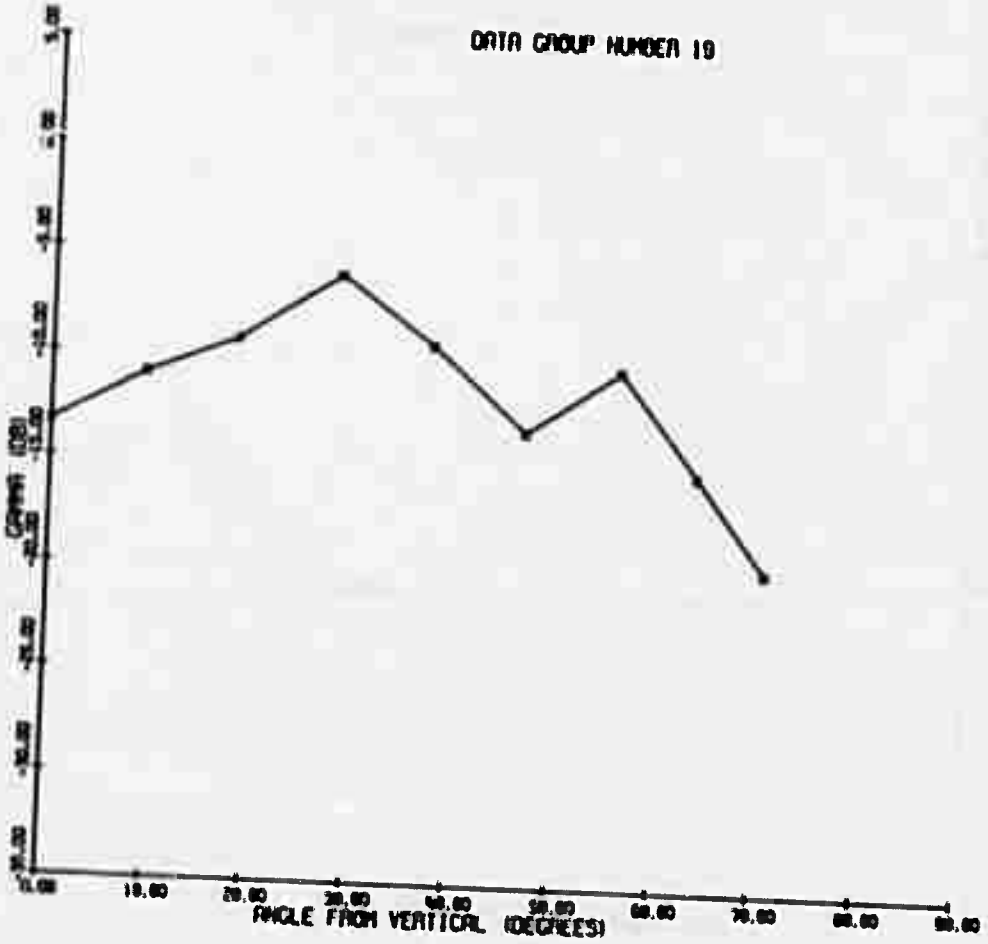
Air Temp. -28C Snow Density

Avg. Snow Depth 10 cm (Varied from 2 cm to 30 cm) Crust 0.376

Sea Ice Surface Temp. -18C Bottom 0.312

Horiz. Wave -First Location

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-65.0	0.0	0.0399	1.83	0.538	0.0741	-11.3
10.0	-62.5	9.0	0.0701	1.82	0.535	0.1311	-8.8
20.0	-62.0	18.0	0.0758	1.81	0.525	0.1444	-8.4
30.0	-59.5	28.0	0.1310	1.79	0.518	0.2531	-6.0
40.0	-64.5	37.0	0.0379	1.75	0.495	0.0765	-11.2
50.0	-62.0	46.0	0.0583	1.69	0.461	0.1267	-9.0
60.0	-60.5	55.0	0.0649	1.59	0.409	0.1588	-8.0
70.0	-63.0	62.0	0.0178	1.33	0.286	0.0624	-12.1
80.0	-61.0	69.0	0.0055	0.89	0.116	0.0477	-13.2



DATA GROUP NUMBER 19

Pt. Barrow, Rough Sea Ice (Rubble) 1/21/72 Avg. Salinity 3.5 PPT

Air Temp. -28C

Snow Density

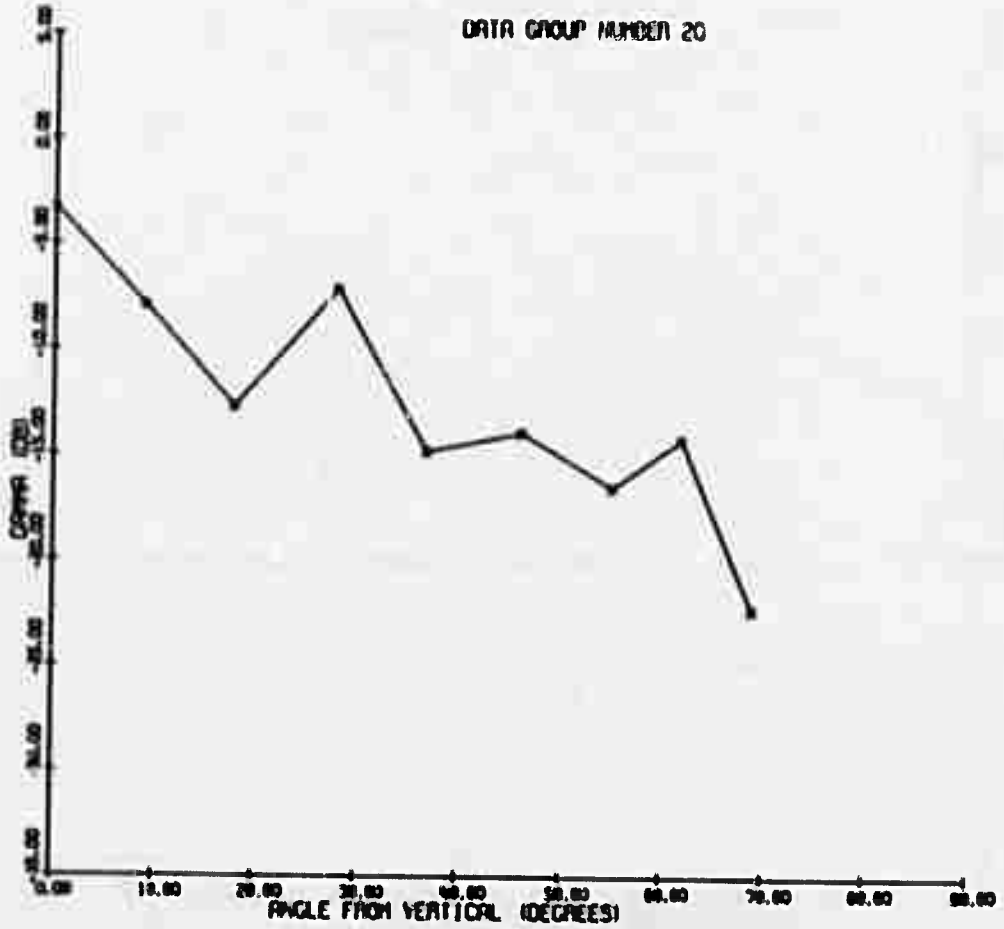
Avg. Snow Depth 10 cm (Varied from 2 cm to 30 cm) Crust 0.376

Sea Ice Surface Temp. -18C

Bottom 0.312

Vert. Wave -First Location

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-67.0	0.0	0.0252	1.83	0.538	0.0468	-13.3
10.0	-64.5	9.2	0.0443	1.82	0.535	0.0828	-10.8
20.0	-62.5	18.3	0.0681	1.81	0.527	0.1292	-8.9
30.0	-59.0	28.3	0.1488	1.80	0.521	0.2857	-5.4
40.0	-61.5	37.5	0.0776	1.77	0.502	0.1548	-8.1
50.0	-64.5	46.7	0.0344	1.71	0.472	0.0730	-11.4
60.0	-60.0	55.8	0.0792	1.63	0.426	0.1858	-7.3
70.0	-62.0	63.8	0.0288	1.42	0.324	0.0890	-10.5
80.0	-60.5	70.8	0.0088	0.97	0.143	0.0612	-12.1



DATA GROUP NUMBER 20

Pt. Barrow, Rough Sea Ice (Rubble) 1/21/72 Avg. Salinity 3.5 PPT

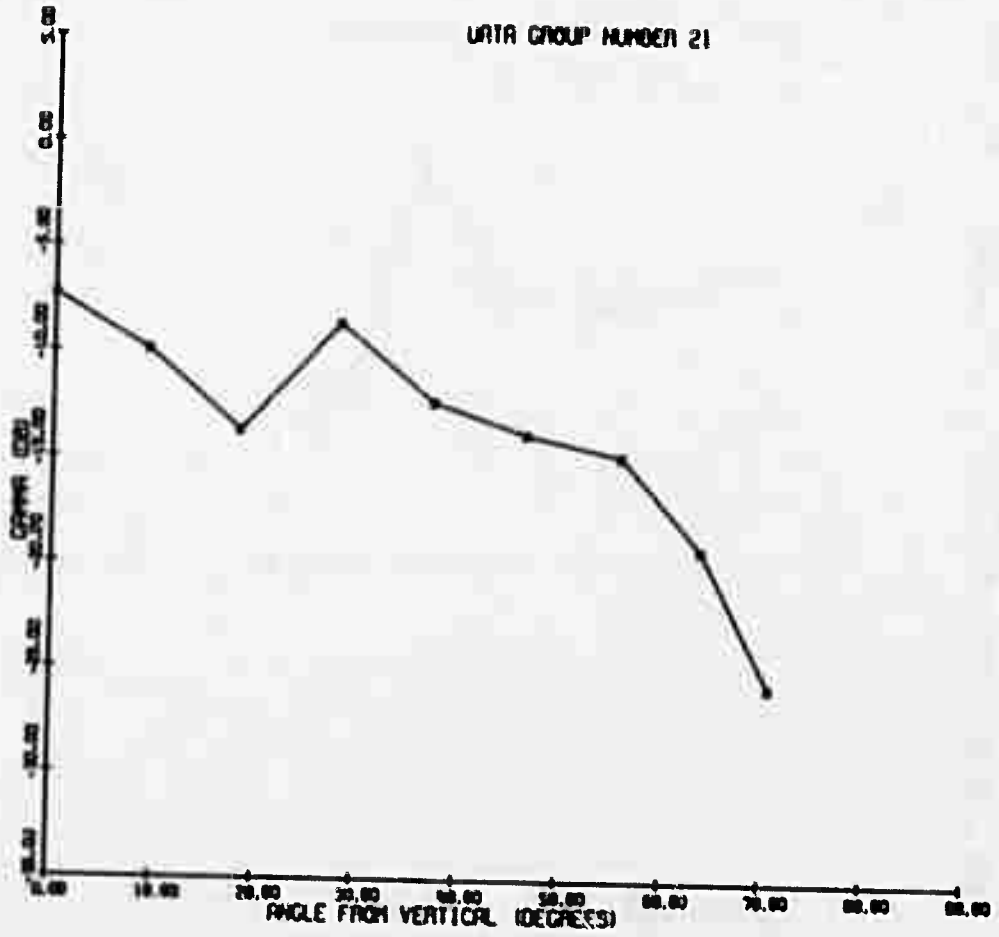
Air Temp. -28C Snow Density

Avg. Snow Depth 10 cm (Varied from 2 cm to 30 cm) Crust 0.376

Sea Ice Surface Temp. -18C Bottom 0.312

Horiz. Wave -Second Location

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-57.0	0.0	0.2516	1.83	0.538	0.4678	-3.3
10.0	-61.5	9.0	0.0883	1.82	0.535	0.1650	-7 9
20.0	-66.0	18.0	0.0302	1.81	0.525	0.0575	-12.4
30.0	-60.0	28.0	0.1167	1.79	0.518	0.2256	-6.5
40.0	-67.0	37.0	0.0213	1.75	0.495	0.0430	-13.7
50.0	-65.0	46.0	0.0292	1.69	0.461	0.0635	-12.0
60.0	-66.0	55.0	0.0183	1.59	0.409	0.0488	-13.5
70.0	-60.5	62.0	0.0317	1.33	0.286	0.1109	-9.6
80.0	-62.5	69.0	0.0039	0.89	0.116	0.0338	-14.7



DATA GROUP NUMBER 21

Pt. Barrow, Rough Sea Ice (Rubble) 1/21/72 Avg. Salinity 3.5 PPT

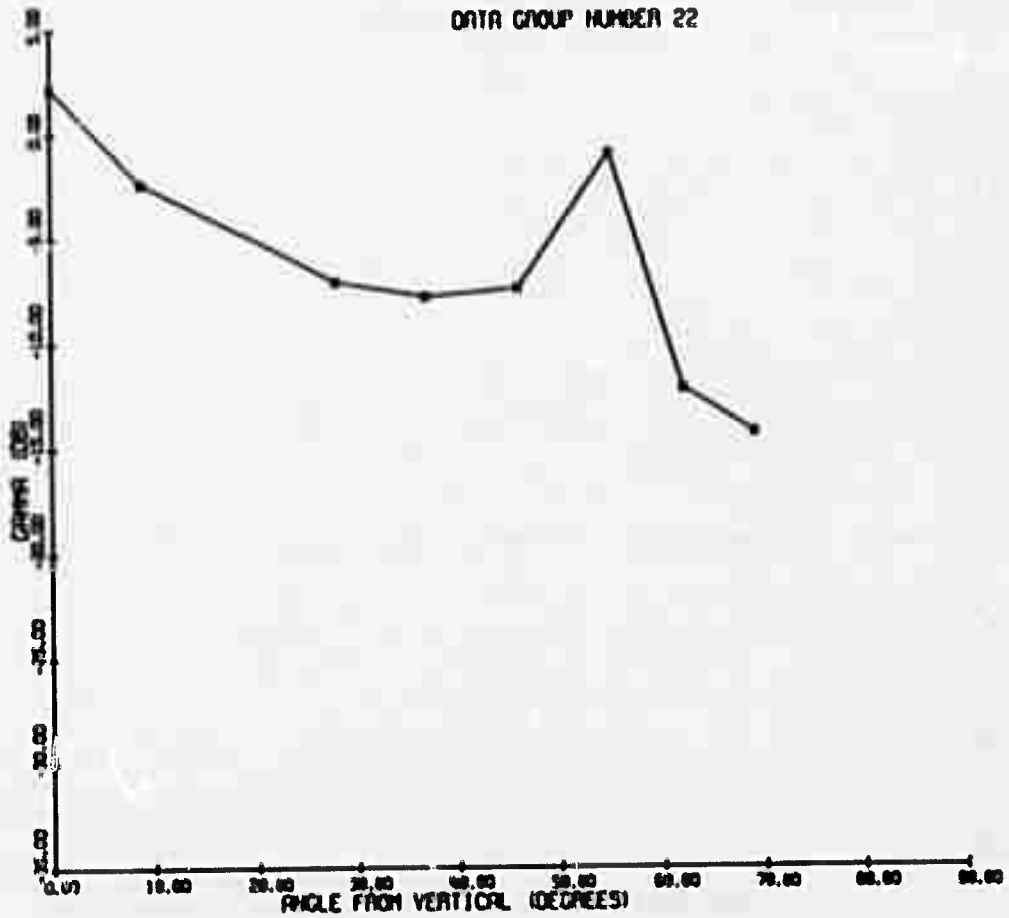
Air Temp. -28C Snow Density

Avg. Snow Depth 10 cm (Varied from 2 cm to 30 cm) Crust 0.376

Sea Ice Surface Temp -18C Bottom 0.312

Vert. Wave -Second Location

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-61.0	0.0	0.1002	1.83	0.538	0.1862	-7.3
10.0	-63.5	9.2	0.0558	1.82	0.535	0.1042	-9.8
20.0	-67.0	18.3	0.0242	1.81	0.527	0.0458	-13.4
30.0	-61.5	28.3	0.0837	1.80	0.521	0.1607	-7.9
40.0	-64.5	37.5	0.0389	1.77	0.502	0.0776	-11.1
50.0	-65.0	46.7	0.0307	1.71	0.472	0.0650	-11.9
60.0	-64.5	55.8	0.0281	1.63	0.426	0.0659	-11.8
70.0	-66.0	63.8	0.0115	1.42	0.324	0.0354	-14.5
80.0	-66.5	70.8	0.0022	0.97	0.143	0.0154	-18.1



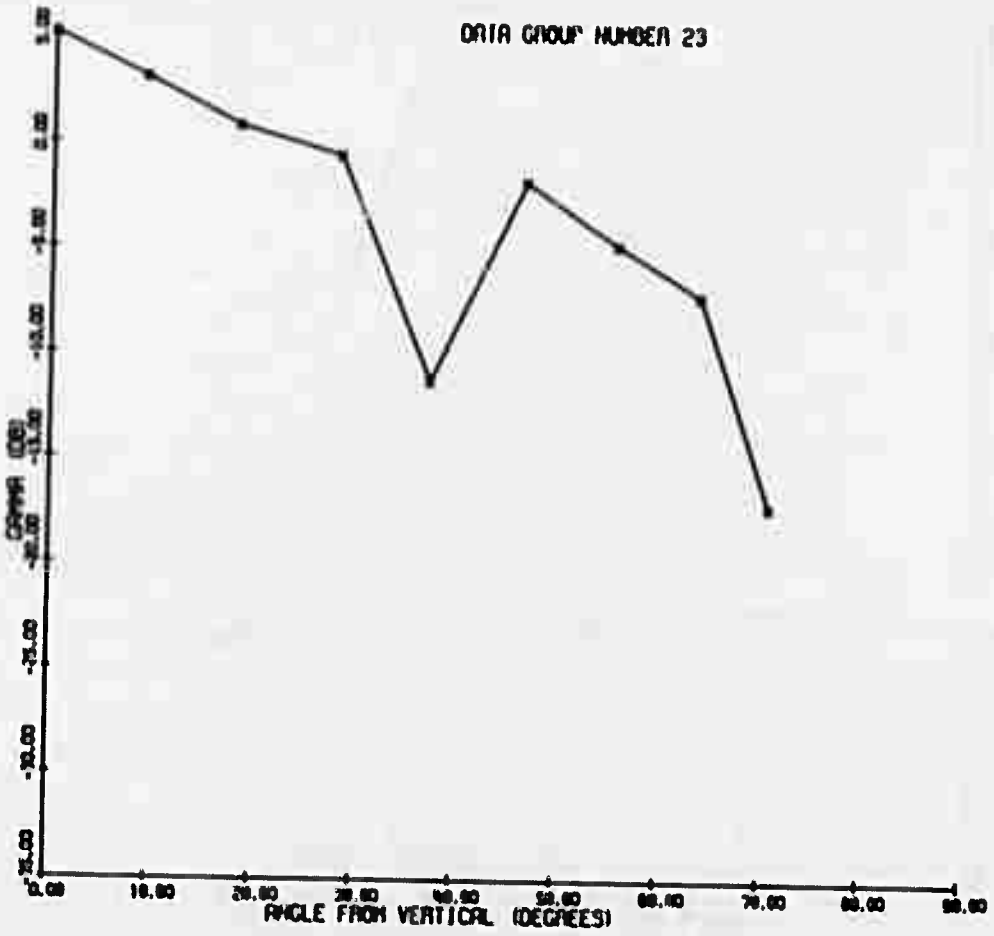
DATA GROUP NUMBER 22

Experimental Farm 3/11/72

Air Temp. -17C Snow Depth 62 cm

Horiz. Wave -From Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	HN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-51.5	0.0	0.8929	1.83	0.538	1.6599	2.2
10.0	-56.0	9.0	0.3131	1.82	0.535	0.5855	-2.3
20.0	NO RETURN						
30.0	-60.0	28.0	0.1167	1.79	0.518	0.2256	-6.5
40.0	-60.0	37.0	0.1068	1.75	0.495	0.2157	-6.7
50.0	-58.5	46.0	0.1306	1.69	0.461	0.2836	-5.5
60.0	-50.5	55.0	0.6491	1.59	0.409	1.5879	2.0
70.0	-58.5	62.0	0.0502	1.33	0.286	0.1758	-7.6
80.0	-54.5	69.0	0.0247	0.89	0.116	0.2131	-6.7



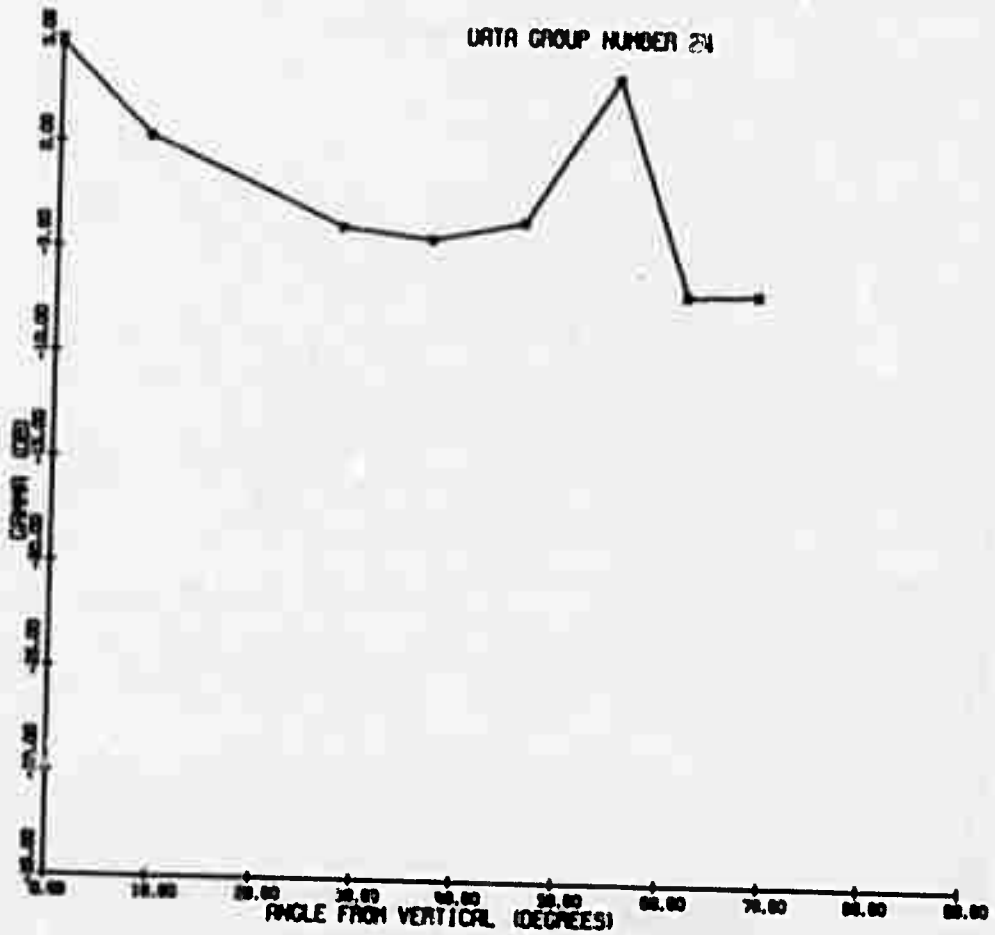
DATA GROUP NUMBER 23

Experimental Farm 3/11/72

Air Temp. -17C Snow Depth 62 cm

Vert. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-48.5	0.0	1.7815	1.83	0.538	3.3118	5.2
10.0	-50.5	9.2	1.1131	1.82	0.535	2.0794	3.2
20.0	-52.5	18.3	0.6811	1.81	0.527	1.2920	1.1
30.0	-53.5	28.3	0.5279	1.80	0.521	1.0138	0.1
40.0	-63.5	37.5	0.0490	1.77	0.502	0.0976	-10.1
50.0	-53.0	46.7	0.4863	1.71	0.472	1.0307	0.1
60.0	-54.5	55.8	0.2811	1.63	0.426	0.6593	-1.8
70.0	-54.0	63.8	0.1816	1.42	0.324	0.5613	-2.5
80.0	-58.0	70.8	0.0156	0.97	0.143	0.1088	-9.6



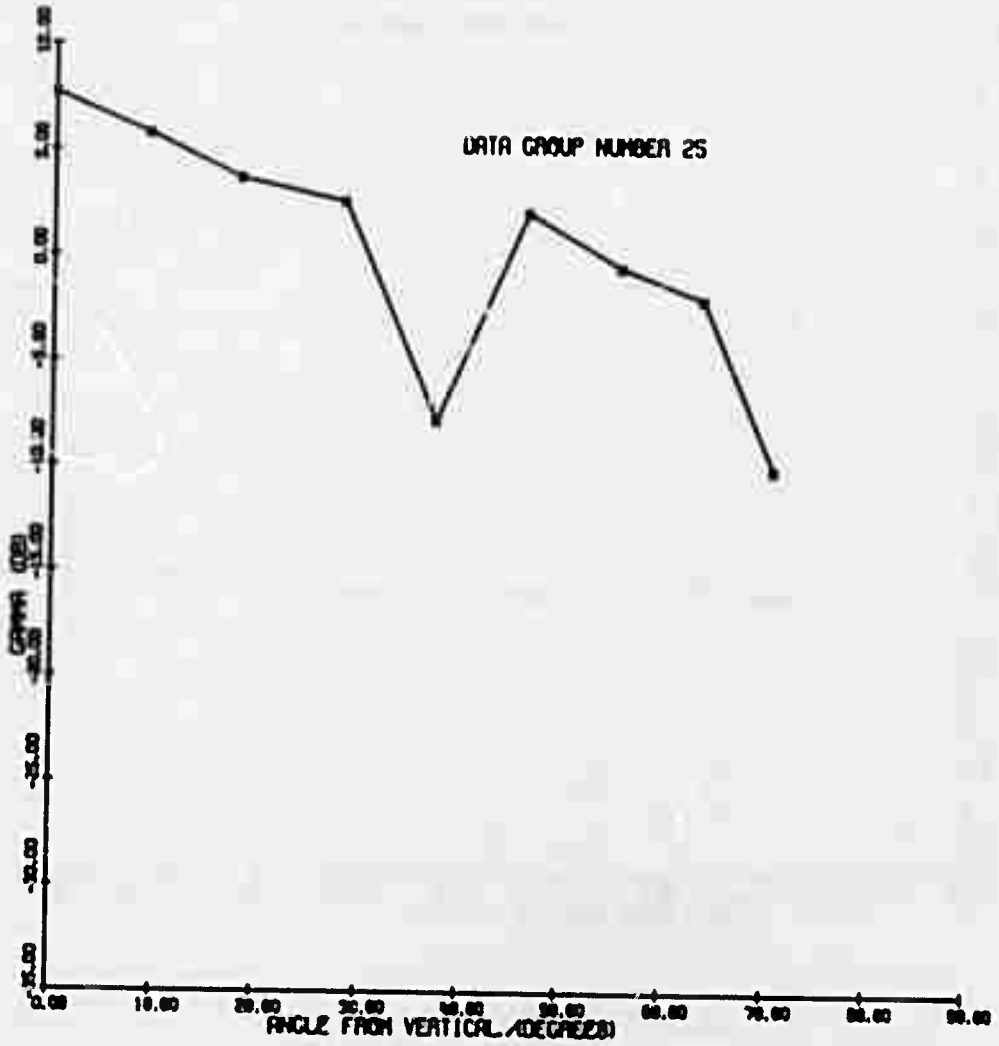
DATA GROUP NUMBER 24

Experimental Farm 3/11/72

Air Temp. -17C Snow Depth 62 cm

Horiz. Wave -from Ground (NSNOW=1.26)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-51.5	0.0	2.8704	2.45	0.964	2.9761	4.7
10.0	-56.0	9.0	1.0817	2.49	0.994	1.0882	0.4
20.0	NO RETURN						
30.0	-60.0	28.0	0.4969	2.58	1.068	0.4654	-3.3
40.0	-60.0	37.0	0.5248	2.61	1.097	0.4783	-3.2
50.0	-58.5	46.0	0.7722	2.64	1.120	0.6895	-1.6
60.0	-50.5	55.0	4.3990	2.64	1.123	4.3624	6.4
70.0	-58.5	62.0	0.5887	2.47	0.978	0.6020	-2.2
80.0	-54.5	69.0	0.7844	2.10	0.653	1.2015	0.8



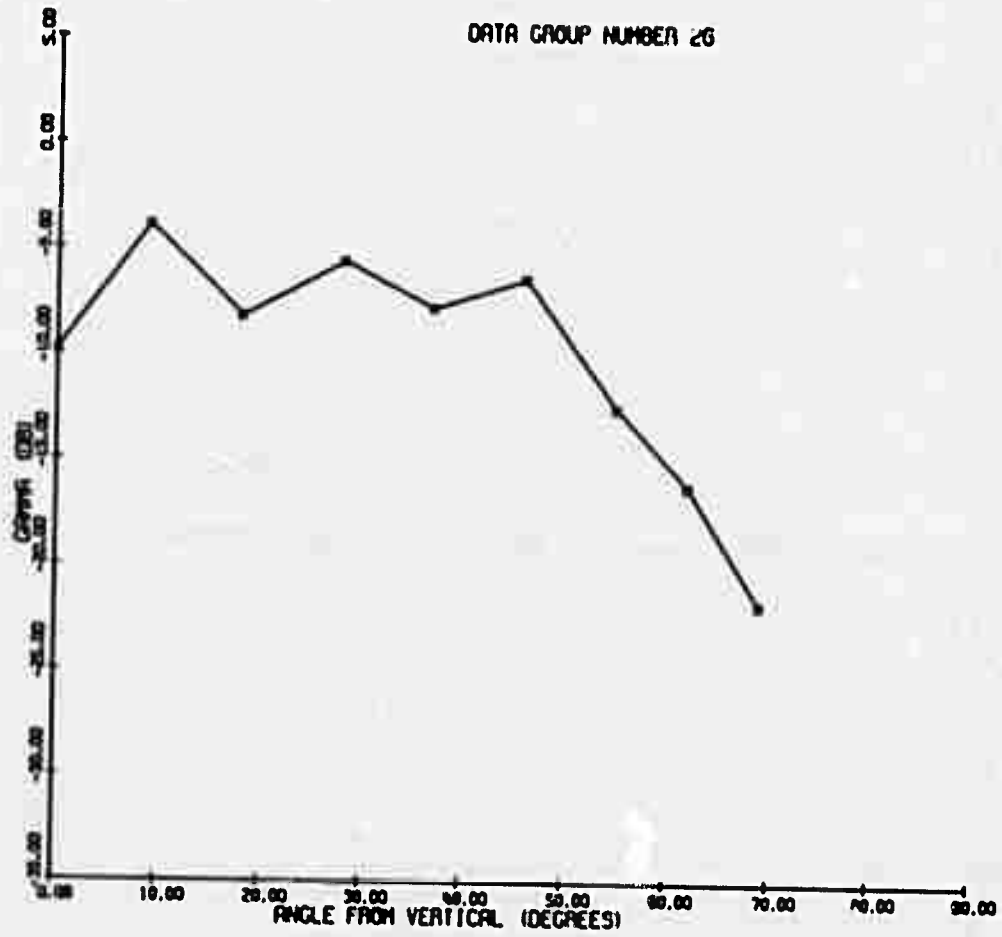
DATA GROUP NUMBER 25

Experimental Farm 3/11/72

Air Temp. -17C Snow Depth 62 cm

Vert. Wave -from Ground (NSNOW=1.26)

ANG. (DEG.)	PH/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-48.5	0.0	5.7272	2.45	0.964	5.9381	7.7
10.0	-50.5	9.2	3.8487	2.49	0.995	3.8666	5.9
20.0	-52.5	18.3	2.5818	2.53	1.026	2.5156	4.0
30.0	-53.5	28.3	2.2473	2.58	1.074	2.0918	3.2
40.0	-63.5	37.5	0.2403	2.63	1.111	0.2163	-6.6
50.0	-53.0	46.7	2.8561	2.67	1.143	2.4978	4.0
60.0	-54.5	55.8	2.0828	2.69	1.161	1.7947	2.5
70.0	-54.0	63.8	1.9709	2.57	1.066	1.8492	2.7
80.0	-58.0	70.8	0.4229	2.21	0.747	0.5662	-2.5



DATA GROUP NUMBER 26

Mier Lake, Snow Over Fresh Lake Ice 3/25/72

Air Temp. -3C

Snow Dens. Temp. Profile

Snow Depth 36 cm

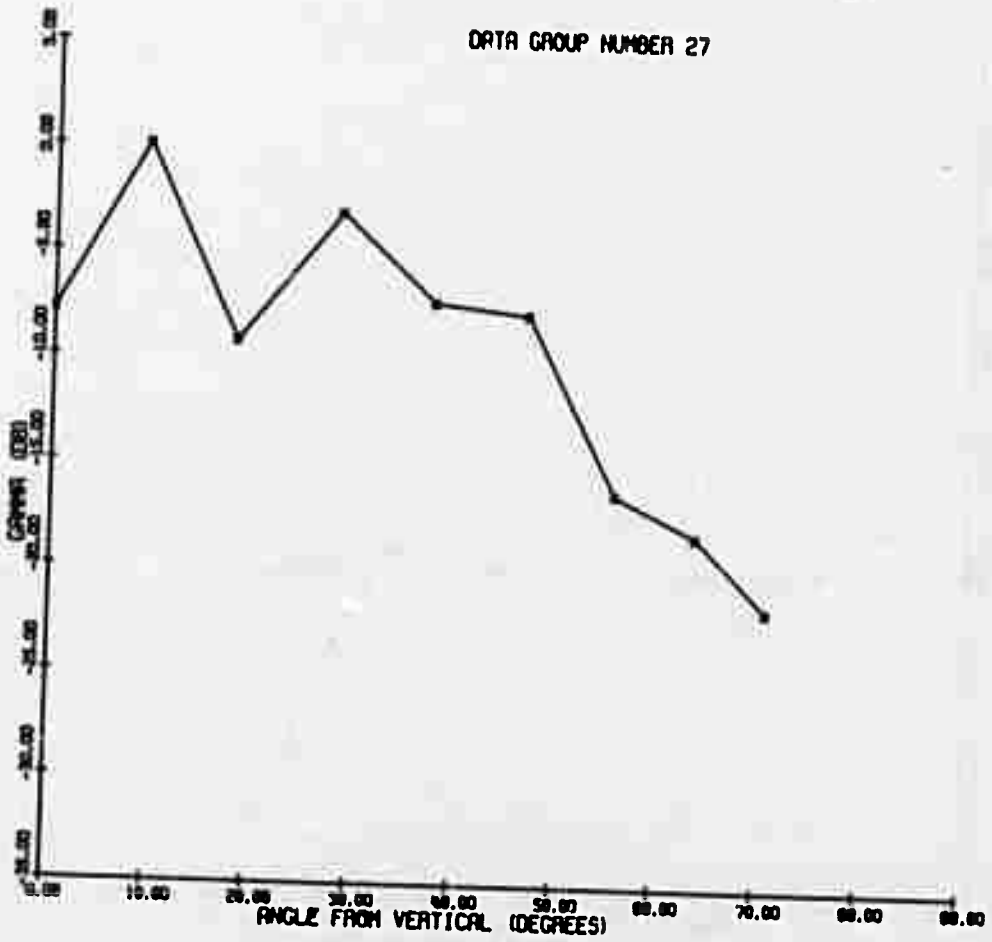
2 cm 0.294 0 cm -3.0 C

20 cm 0.354 18 cm -4.0 C

36 cm 0.302 36 cm -2.5 C

Horiz. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-63.5	0.0	0.0563	1.83	0.538	0.1047	-9.8
10.0	-57.5	9.0	0.2217	1.82	0.535	0.4145	-3.8
20.0	-61.5	18.0	0.0851	1.81	0.525	0.1620	-7.9
30.0	-58.5	28.0	0.1649	1.79	0.518	0.3186	-5.0
40.0	-60.0	37.0	0.1068	1.75	0.495	0.2157	-6.7
50.0	-57.5	46.0	0.1644	1.69	0.461	0.3570	-4.5
60.0	-62.0	55.0	0.0460	1.59	0.409	0.1124	-9.5
70.0	-62.5	62.0	0.0200	1.33	0.286	0.0700	-11.6
80.0	-62.0	69.0	0.0044	0.89	0.116	0.0379	-14.2



DATA GROUP NUMBER 27

Mier Lake, Snow Over Fresh Lake Ice — 3/25/72

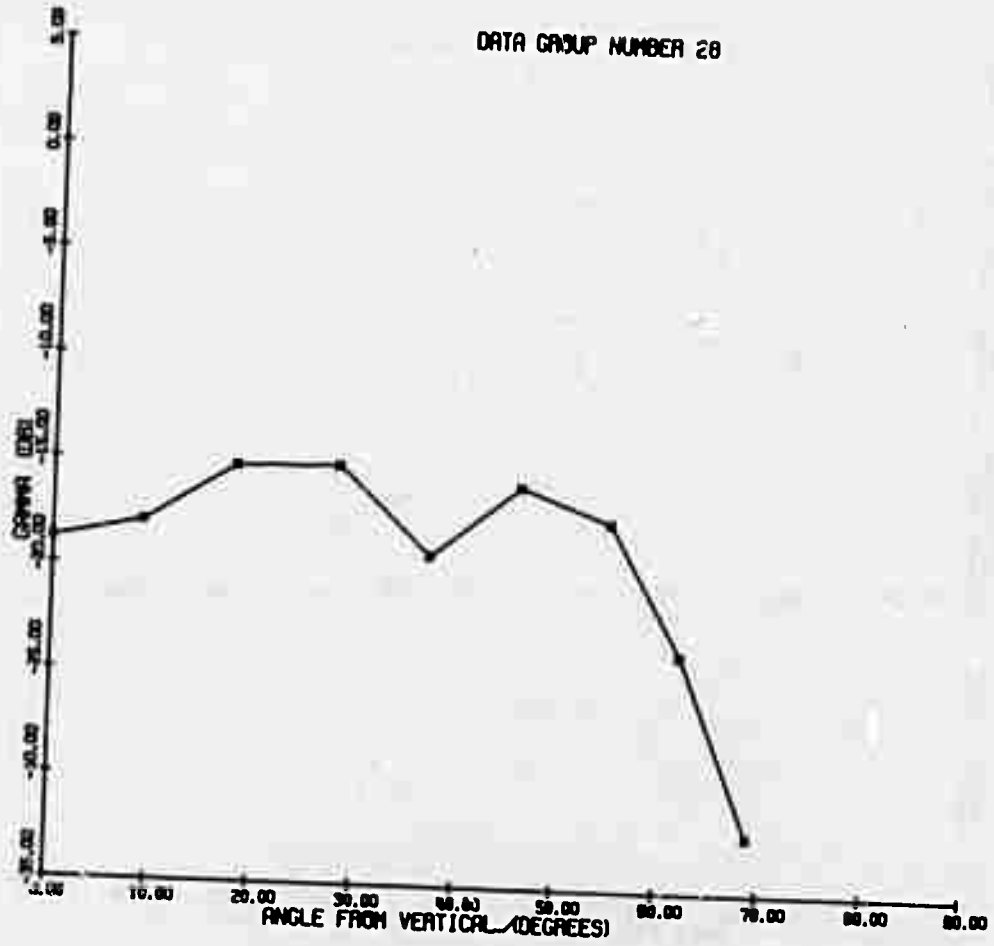
Air Temp. -3C

Snow Depth 36 cm

Snow Dens.	Temp. Profile
2 cm 0.294	0 cm -3.0 C
20 cm 0.354	18 cm -4.0 C
36 cm 0.302	36 cm -2.5 C

Vert. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-61.5	0.0	0.0893	1.83	0.538	0.1660	-7.8
10.0	-53.5	9.2	0.5579	1.82	0.535	1.0422	0.2
20.0	-62.5	18.3	0.0681	1.81	0.527	0.1292	-8.9
30.0	-56.0	28.3	0.2968	1.80	0.521	0.5701	-2.4
40.0	-59.5	37.5	0.1230	1.77	0.502	0.2453	-6.1
50.0	-59.0	46.7	0.1222	1.71	0.472	0.2589	-5.9
60.0	-66.0	55.8	0.0199	1.63	0.426	0.0467	-13.3
70.0	-65.0	63.8	0.0144	1.42	0.324	0.0466	-13.5
80.0	-62.5	70.8	0.0055	0.97	0.143	0.0386	-14.1



DATA GROUP NUMBER 28

Mier Lake, Snow Over Fresh Lake Ice 3/25/72

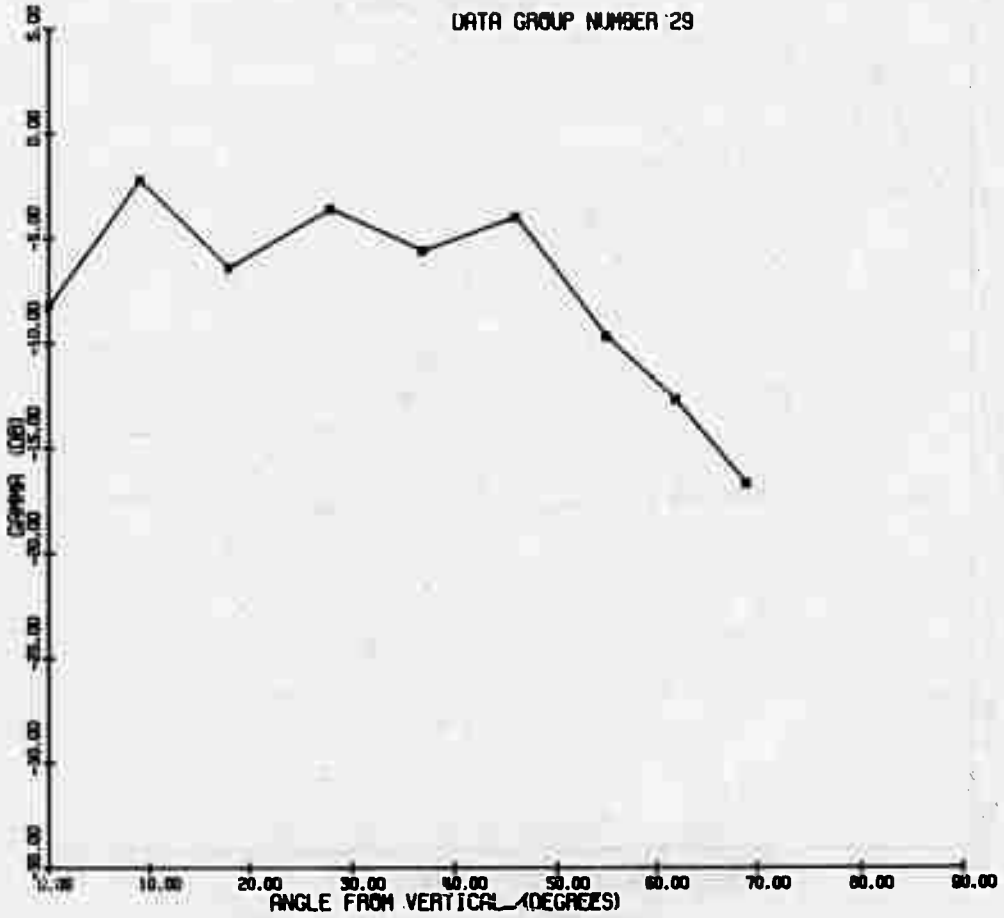
Air Temp. -3C

Snow Depth 36 cm

Snow Dens.	Temp. Profile
2 cm 0.294	0 cm -3.0 C
20 cm 0.354	18 cm -4.0 C
36 cm 0.302	36 cm -2.5 C

Orth. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-72.5	0.0	0.0071	1.83	0.538	0.0132	-18.8
10.0	-71.5	9.0	0.0088	1.82	0.535	0.0165	-17.8
20.0	-68.5	18.0	0.0170	1.81	0.525	0.0323	-14.9
30.0	-68.0	28.0	0.0185	1.79	0.518	0.0357	-14.5
40.0	-71.5	37.0	0.0076	1.75	0.495	0.0153	-18.2
50.0	-67.0	46.0	0.0184	1.69	0.461	0.0401	-14.0
60.0	-67.0	55.0	0.0145	1.59	0.409	0.0355	-14.5
70.0	-70.0	62.0	0.0036	1.33	0.286	0.0124	-19.1
80.0	-72.5	69.0	0.0004	0.89	0.116	0.0034	-24.7



DATA GROUP NUMBER 29

Mier Lake, Snow Over Fresh Lake Ice 3/25/72

Air Temp. -3C Snow Dens. Temp. Profile

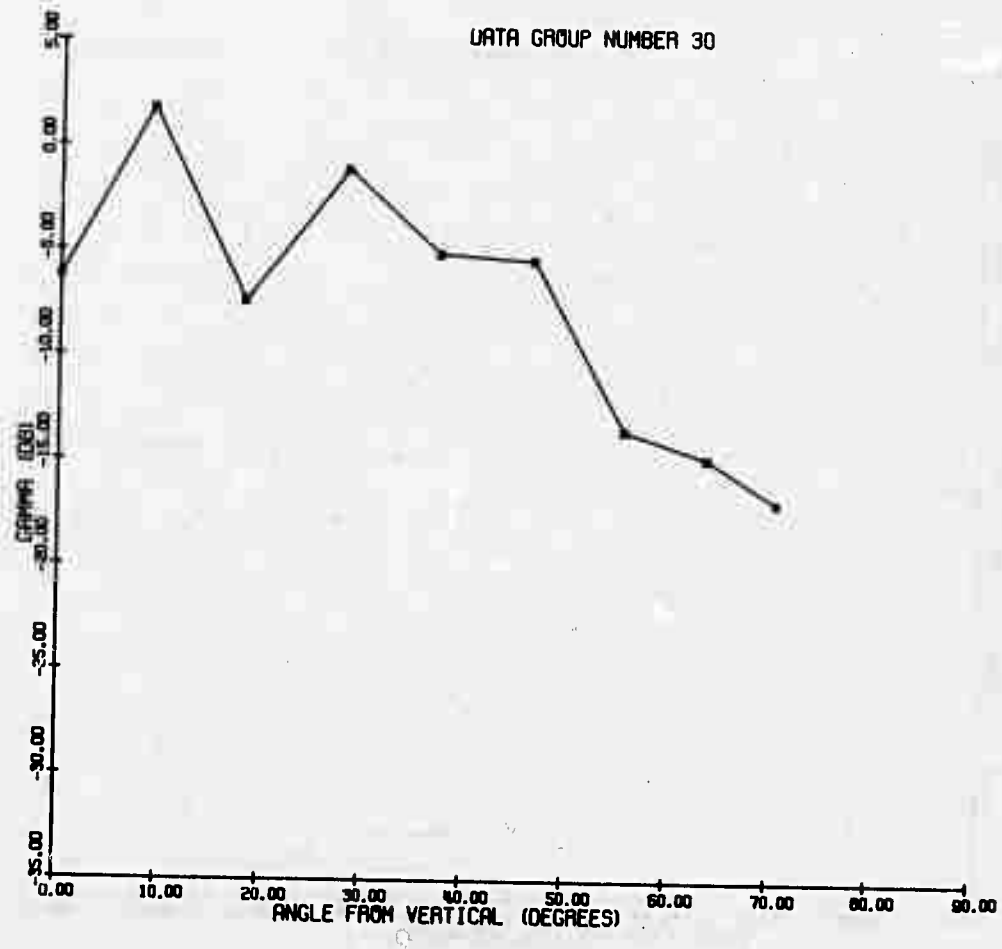
Snow Depth 36 cm 2 cm 0.294 0 cm -3.0 C

20 cm 0.354 18 cm -4.0 C

36 cm 0.302 36 cm -2.5 C

Horiz. Wave -from Ice Surface (NSNOW=1.26)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-63.5	0.0	0.1156	2.19	0.771	0.1500	-8.2
10.0	-57.5	9.0	0.4767	2.21	0.784	0.6078	-2.2
20.0	-61.5	18.0	0.1943	2.22	0.794	0.2449	-6.1
30.0	-58.5	28.0	0.4069	2.25	0.813	0.5005	-3.0
40.0	-60.0	37.0	0.2901	2.25	0.816	0.3556	-4.5
50.0	-57.5	46.0	0.5064	2.24	0.808	0.6265	-2.0
60.0	-62.0	55.0	0.1675	2.20	0.780	0.2146	-6.7
70.0	-62.5	62.0	0.0995	1.99	0.637	0.1562	-8.1
80.0	-62.0	69.0	0.0459	1.59	0.374	0.1225	-9.1



DATA GROUP NUMBER 30

Mier Lake, Snow Over Fresh Lake Ice 3/25/72

Air Temp. -3C Snow Dens. Temp. Profile

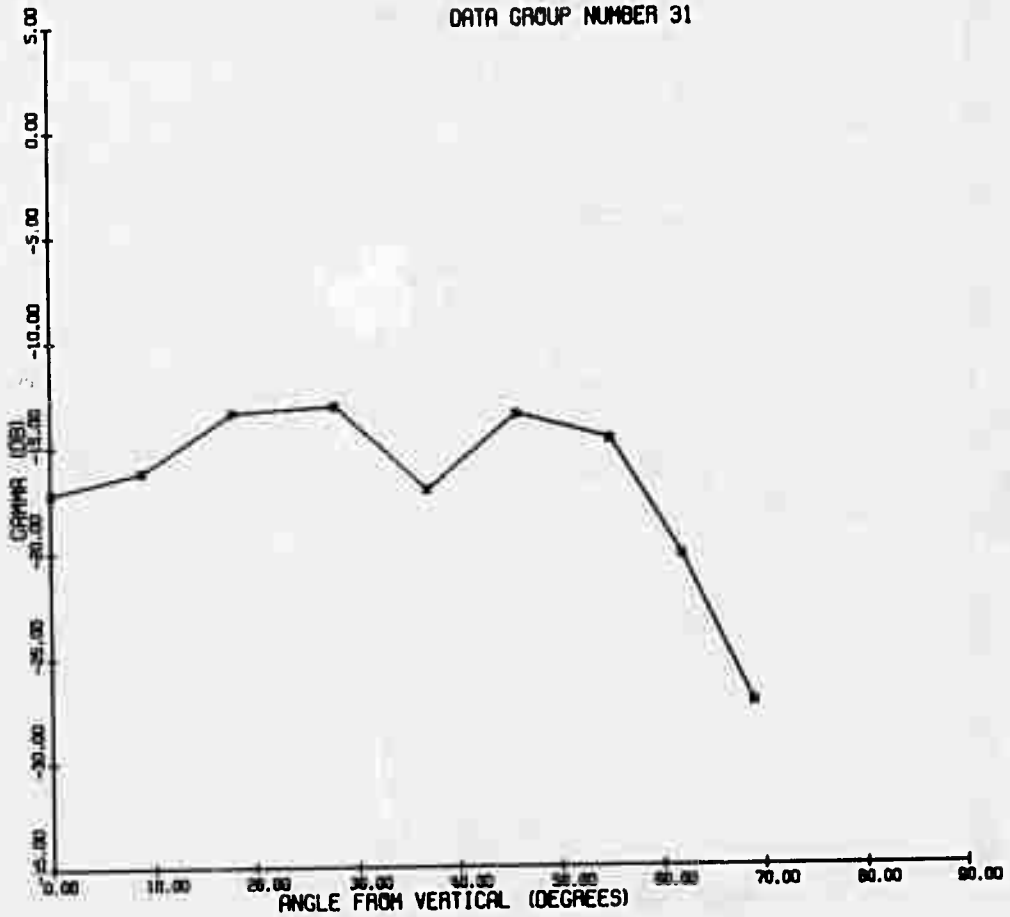
Snow Depth 36 cm 2 cm 0.294 0 cm -3.0 C

20 cm 0.354 18 cm -4.0 C

36 cm 0.302 36 cm -2.5 C

Vert. Wave -from Ice Surface (NSNOW=1.26)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-61.5	0.0	0.1832	2.19	0.771	0.2378	-6.2
10.0	-53.5	9.2	1.2004	2.21	0.785	1.5287	1.8
20.0	-62.5	18.3	0.1557	2.23	0.797	0.1953	-7.1
30.0	-56.0	28.3	0.7327	2.26	0.818	0.8956	-0.5
40.0	-59.5	37.5	0.3339	2.27	0.826	0.4041	-3.9
50.0	-59.0	46.7	0.3745	2.27	0.826	0.4533	-3.4
60.0	-66.0	55.8	0.0716	2.24	0.809	0.0885	-10.5
70.0	-65.0	63.8	0.0680	2.09	0.702	0.0968	-10.1
80.0	-62.5	70.8	0.0512	1.69	0.436	0.1174	-9.3



DATA GROUP NUMBER 31

Mier Lake, Snow Over Fresh Lake Ice 3/25/72

Air Temp. -3C

Snow Dens.

Temp. Profile

Snow Depth 36 cm

2 cm 0.294

20 cm 0.354

36 cm 0.302

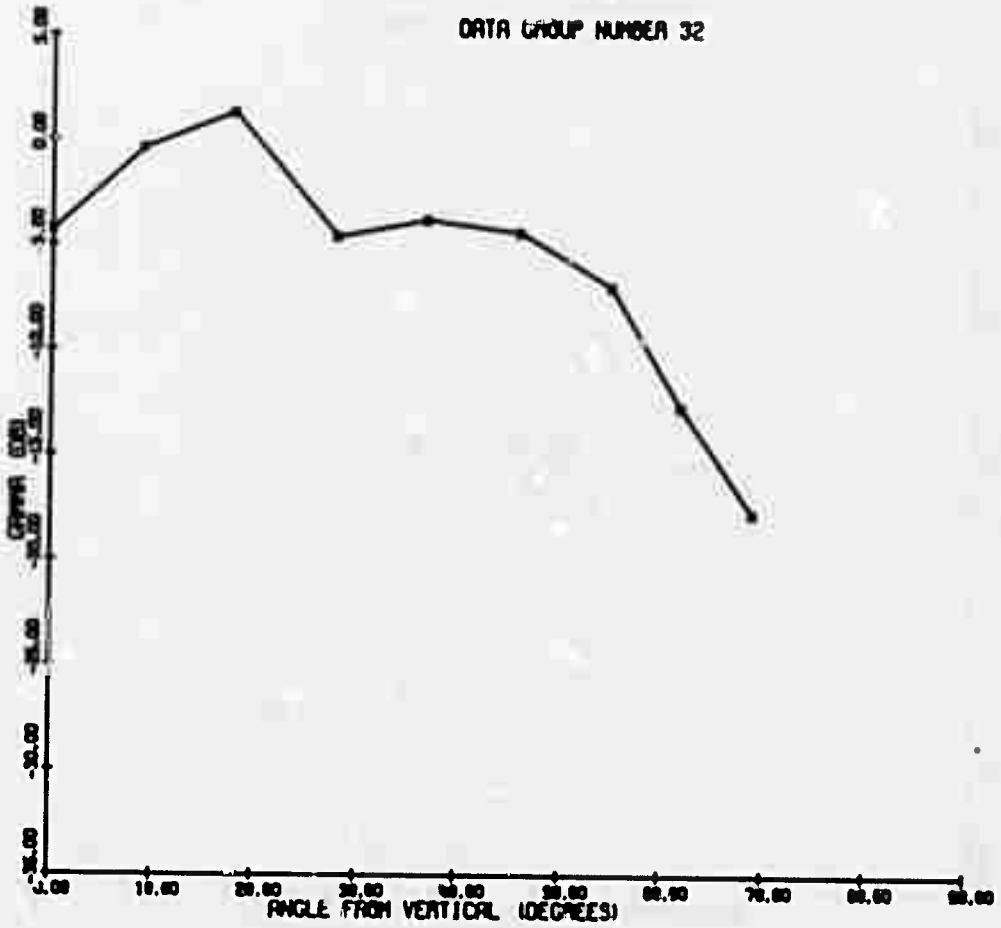
0 cm -3.0 C

18 cm -4.0 C

36 cm -2.5 C

Orth. Wave -from Ice Surface (NSNOW=1.26)

ANG. (DEG.)	PR/PT. (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-72.5	0.0	0.0146	2.19	0.771	0.0189	-17.2
10.0	-71.5	9.0	0.0190	2.21	0.784	0.0242	-16.2
20.0	-68.5	18.0	0.0388	2.22	0.794	0.0489	-13.1
30.0	-68.0	28.0	0.0457	2.25	0.813	0.0562	-12.5
40.0	-71.5	37.0	0.0205	2.25	0.816	0.0252	-16.0
50.0	-67.0	46.0	0.0568	2.24	0.808	0.0703	-11.5
60.0	-67.0	55.0	0.0530	2.20	0.780	0.0679	-11.7
70.0	-70.0	62.0	0.0177	1.99	0.637	0.0278	-15.6
80.0	-72.5	69.0	0.0041	1.59	0.374	0.0109	-19.6



DATA GROUP NUMBER 32

Pt. Barrow, Moderately Rough Sea Ice 3/30/72

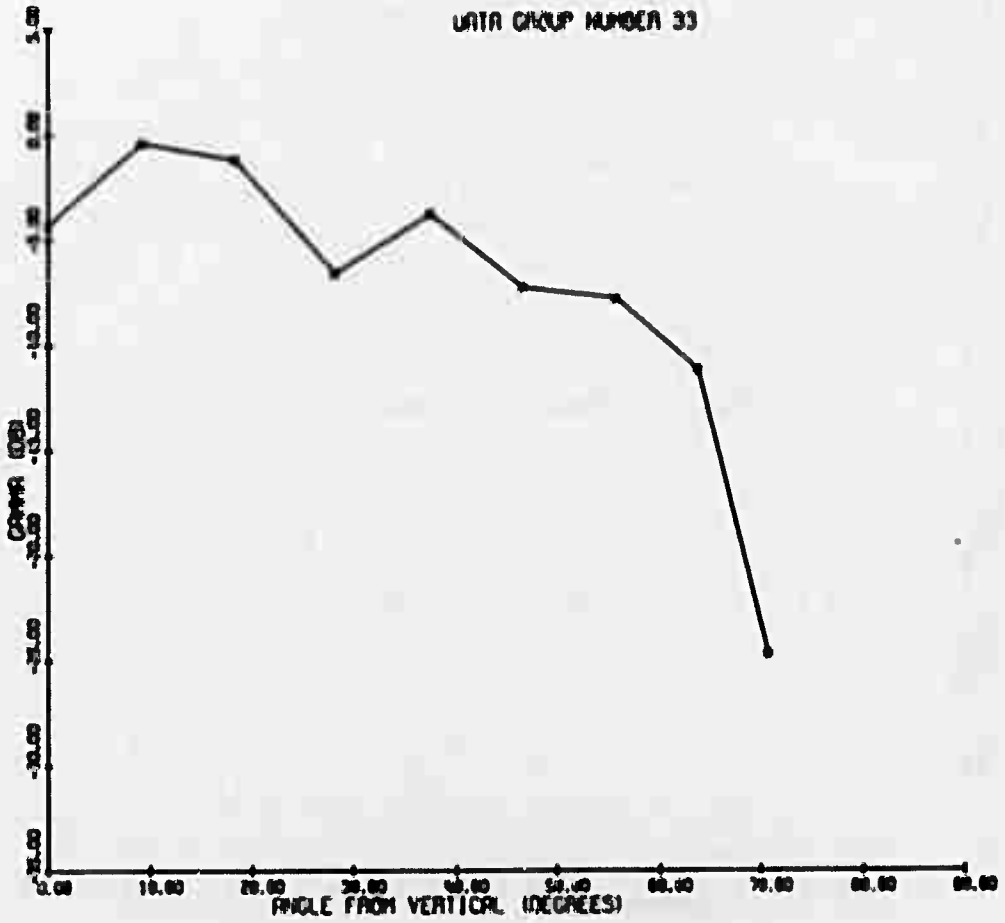
Air Temp. -23C

Snow Depth 40 cm

Snow Dens.	Temp. Profile
2 cm 0.328	0 cm -23 C
20 cm 0.435	15 cm -19 C
40 cm 0.274	29 cm -16 C
	40 cm -12 C

Horiz. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.0	0.0	0.1999	1.83	0.538	0.3716	-4.3
10.0	-54.0	9.0	0.4963	1.82	0.535	0.9280	-0.3
20.0	-52.0	18.0	0.7584	1.81	0.525	1.4442	1.6
30.0	-57.5	28.0	0.2076	1.79	0.518	0.4011	-4.0
40.0	-56.0	37.0	0.2682	1.75	0.495	0.5419	-2.7
50.0	-55.5	46.0	0.2606	1.69	0.461	0.5658	-2.5
60.0	-56.5	55.0	0.1630	1.59	0.409	0.3989	-4.0
70.0	-59.0	62.0	0.0447	1.33	0.286	0.1567	-8.1
80.0	-58.0	69.0	0.0110	0.89	0.116	0.0952	-10.2



DATA GROUP NUMBER 33

Pt. Barrow, Moderately Rough Sea Ice 3/30/72

Air Temp. -23C Snow Dens. Temp. Profile

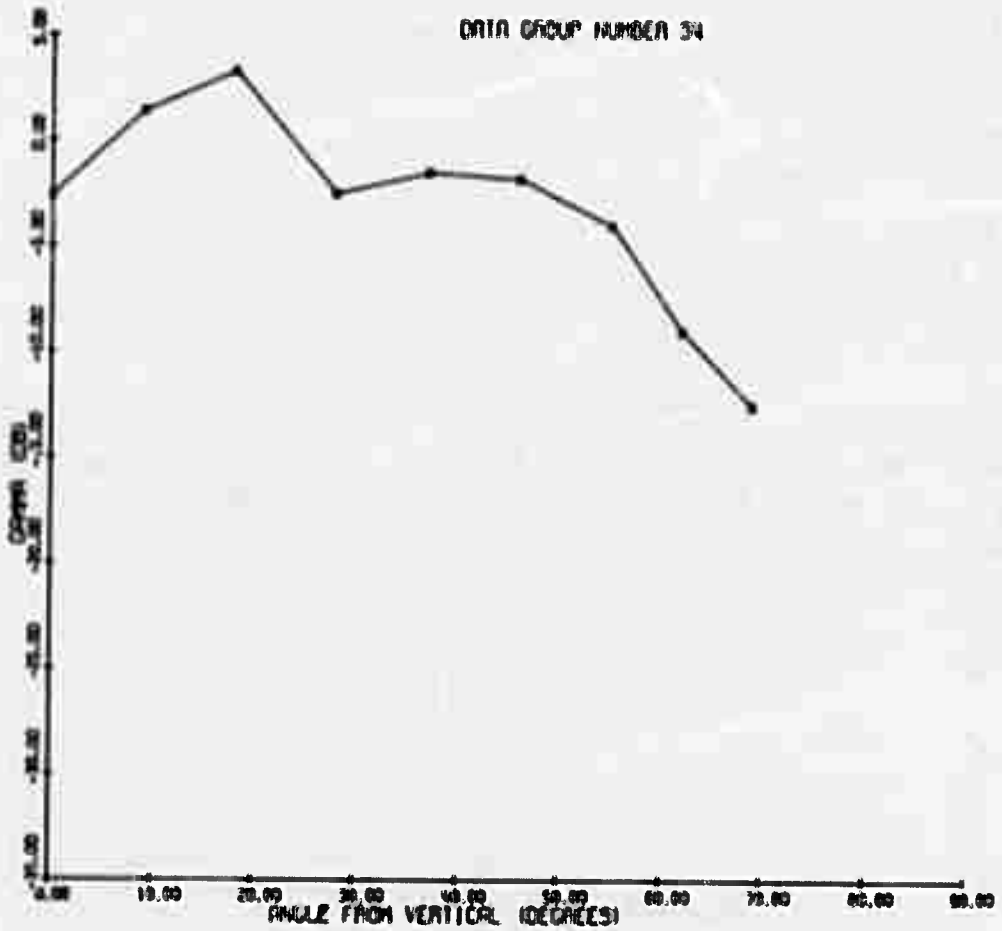
Snow Depth 40 cm 2 cm 0.328 0 cm -23 C

20 cm 0.435 15 cm -19 C

40 cm 0.274 29 cm -16 C

Vert. Wave -from Snow Surface 40 cm -12 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.0	0.0	0.1999	1.82	0.538	0.3716	-4.3
10.0	-54.0	9.2	0.4972	1.82	0.535	0.9288	-0.3
20.0	-54.5	18.3	0.4297	1.81	0.527	0.8152	-0.9
30.0	-59.5	28.3	0.1326	1.80	0.521	0.2546	-5.9
40.0	-56.0	37.5	0.2754	1.77	0.502	0.5491	-2.6
50.0	-58.5	46.7	0.1371	1.71	0.472	0.2905	-5.4
60.0	-57.5	55.8	0.1409	1.63	0.426	0.3304	-4.8
70.0	-58.0	63.8	0.0723	1.42	0.324	0.2235	-6.5
80.0	-65.5	70.8	0.0028	0.97	0.143	0.0193	-17.1



DATA GROUP NUMBER 34

Pt. Barrow, Moderately Rough Sea Ice — 3/30/72

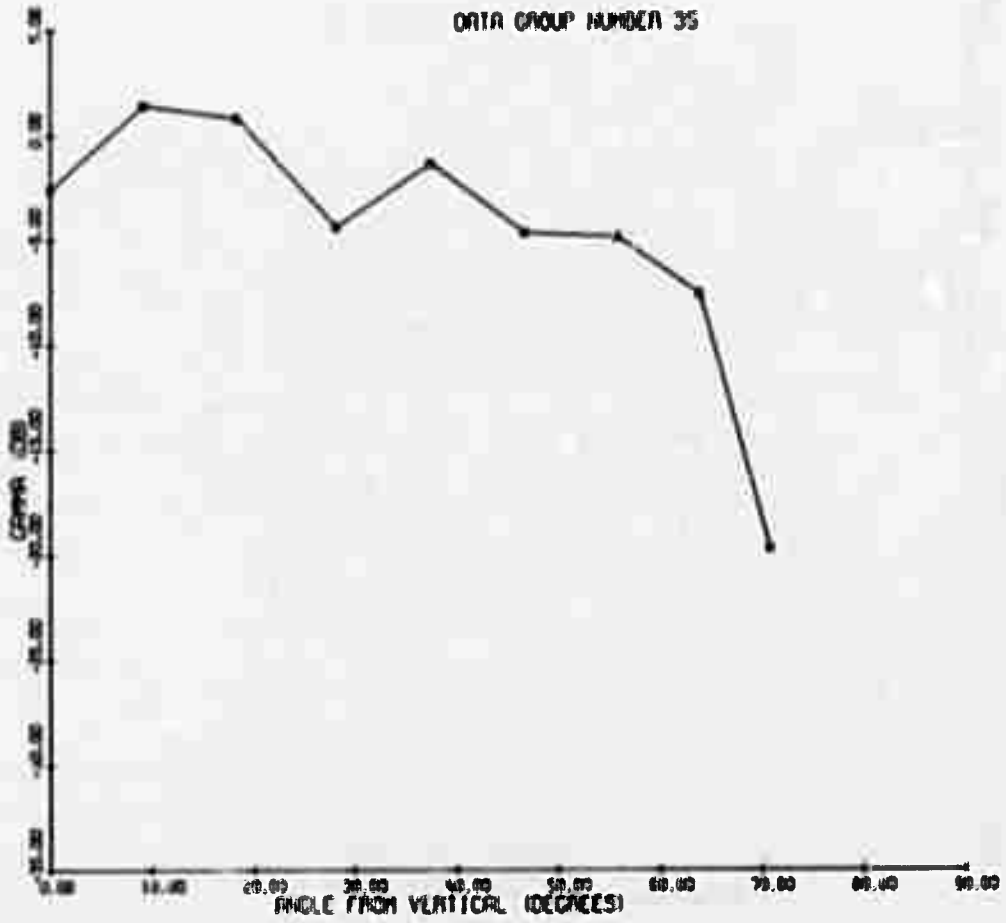
Air Temp. -23 C

Snow Depth 40 cm

Snow Dens.	Temp. Profile
2 cm 0.328	0 cm -23 C
20 cm 0.435	15 cm -19 C
40 cm 0.274	29 cm -16 C
	40 cm -12 C

Vert. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.0	0.0	0.4410	2.23	0.799	0.5519	-2.6
10.0	-54.0	9.0	1.1503	2.25	0.814	1.4128	1.5
20.0	-52.0	18.0	1.8727	2.27	0.825	2.2694	3.6
30.0	-57.5	28.0	0.5554	2.29	0.847	0.6561	-1.8
40.0	-56.0	37.0	0.7926	2.30	0.851	0.9315	-0.3
50.0	-55.5	46.0	0.8751	2.29	0.844	1.0368	0.2
60.0	-56.5	55.0	0.6491	2.25	0.816	0.7959	-1.0
70.0	-59.0	62.0	0.2451	2.04	0.668	0.3668	-4.4
80.0	-58.0	69.0	0.1291	1.64	0.396	0.3258	-4.9



DATA GROUP NUMBER 35

Pt. Barrow, Moderately Rough Sea Ice 3/30/72

Air Temp. -23 C Snow Dens. Temp. Profile

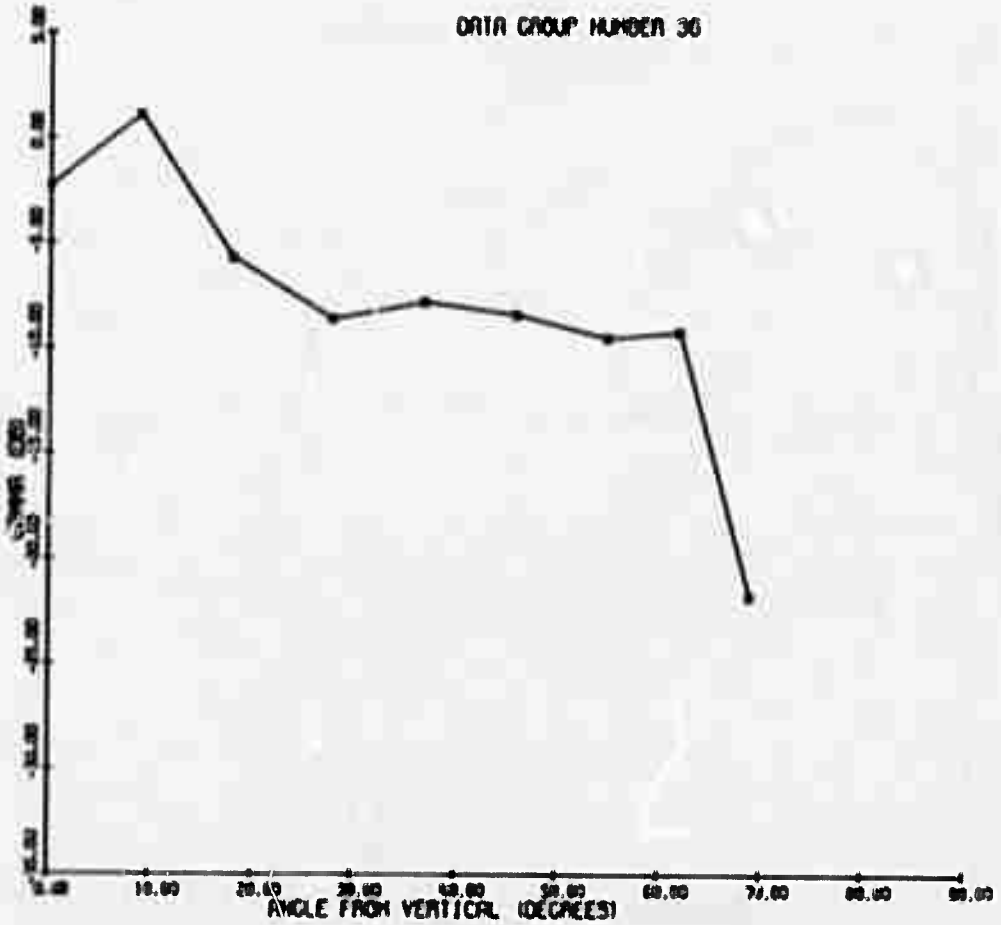
Snow Depth 40 cm 2 cm 0.328 0 cm -23 C

20 cm 0.435 15 cm -19 C

40 cm 0.274 29 cm -16 C

Vert. Wave -from Ice Surface (NSNOW=1.30) 40 cm -12 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.0	0.0	0.4410	2.23	0.799	0.5519	-2.6
10.0	-54.0	9.2	1.1532	2.25	0.815	1.4146	1.5
20.0	-54.5	18.3	1.0618	2.27	0.829	1.2815	1.1
30.0	-59.5	28.3	0.3548	2.30	0.852	0.4166	-3.8
40.0	-56.0	37.5	0.8126	2.31	0.862	0.9432	-0.3
50.0	-58.5	46.7	0.4578	2.32	0.862	0.5309	-2.7
60.0	-57.5	55.8	0.5528	2.29	0.845	0.6546	-1.8
70.0	-58.0	63.8	0.3727	2.14	0.735	0.5074	-2.9
80.0	-65.5	70.8	0.0286	1.73	0.460	0.0621	-12.1



DATA GROUP NUMBER 36

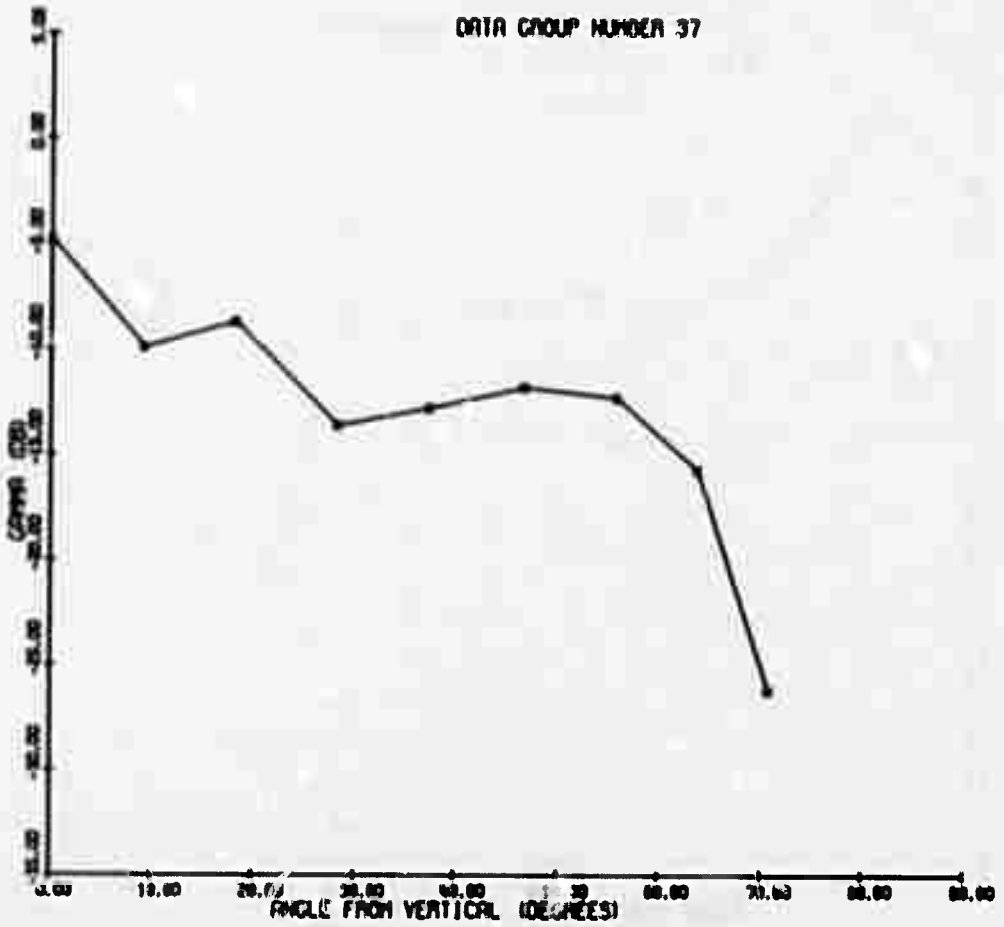
Pt. Barrow, Elson Lagoon 3/31/72 Smooth Sea Ice

Air Temp. -22C Ice Surface Temp. -24C Salinity 7.2 PPT

Snow Depth 8 cm Snow Density 0.326

Horiz. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-56.0	0.0	0.3168	1.83	0.538	0.5889	-2.3
10.0	-52.5	9.0	0.7010	1.82	0.535	1.3108	1.2
20.0	-59.0	18.0	0.1513	1.81	0.525	0.2882	-5.4
30.0	-61.5	28.0	0.0826	1.79	0.518	0.1597	-8.0
40.0	-60.0	37.0	0.1068	1.75	0.495	0.2157	-6.7
50.0	-59.5	46.0	0.1037	1.69	0.461	0.2252	-6.5
60.0	-59.0	55.0	0.0917	1.59	0.409	0.2243	-6.5
70.0	-55.5	62.0	0.1001	1.33	0.286	0.3507	-4.6
80.0	-62.0	69.0	0.0044	0.89	0.116	0.0379	-14.2



DATA GROUP NUMBER 37

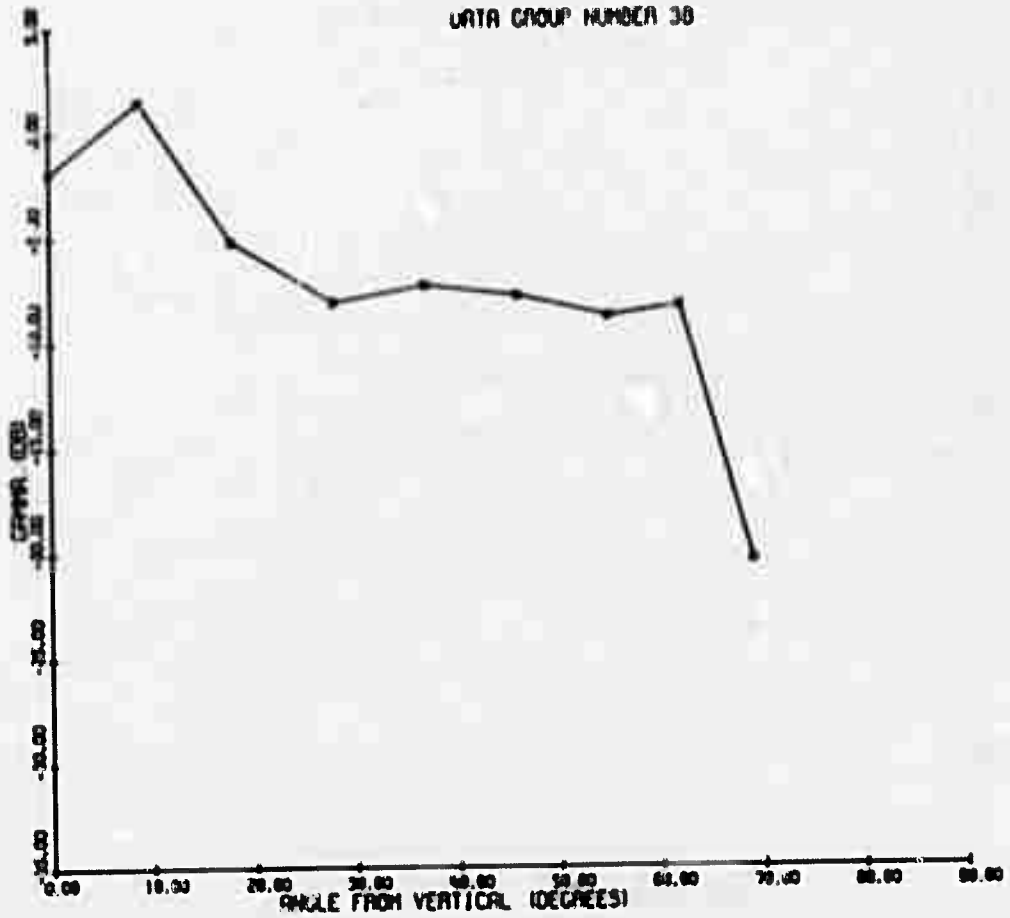
Pt. Barrow, Elson Lagoon 3/31/72 Smooth Sea Ice

Air Temp. -22C Ice Surface Temp. -24C Salinity 7.2 PPT

Snow Depth 8 cm Snow Density 0.32

Vert. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.5	0.0	0.1782	1.83	0.538	0.3312	-4.8
10.0	-63.5	9.2	0.0558	1.82	0.505	0.1042	-9.8
20.0	-62.0	18.3	0.0764	1.81	0.527	0.1450	-8.4
30.0	-66.5	28.3	0.0265	1.80	0.521	0.0508	-12.9
40.0	-65.0	37.5	0.0347	1.77	0.502	0.0691	-11.6
50.0	-63.0	46.7	0.0486	1.71	0.472	0.1031	-9.9
60.0	-62.0	55.8	0.0500	1.63	0.426	0.1172	-9.3
70.0	-62.5	63.8	0.0257	1.42	0.324	0.0793	-11.0
80.0	-67.0	70.8	0.0020	0.97	0.143	0.0137	-18.6



DATA GROUP NUMBER 38

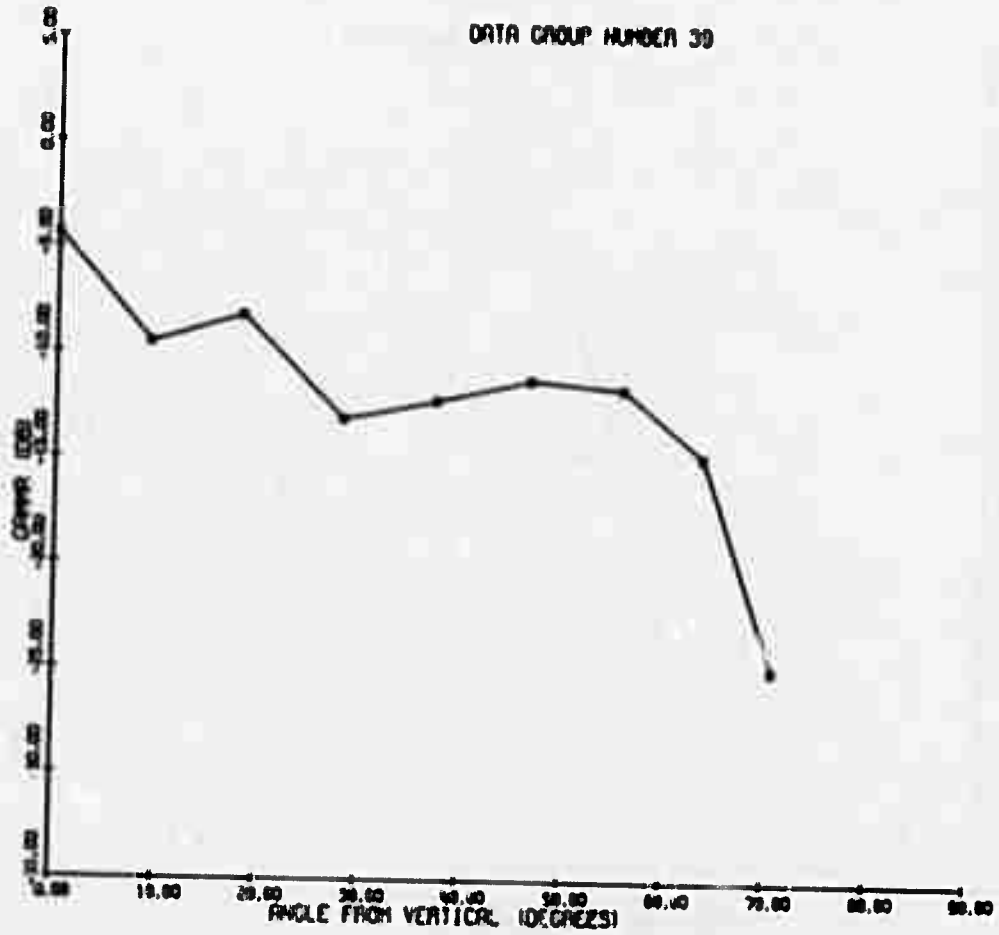
Pt. Barrow, Elson Lagoon 3/31/72 Smooth Sea Ice

Air Temp. -22C Ice Surface Temp. -24C Salinity 7.2 PPT

Snow Depth 8 cm Snow Density 0.326

Horiz. Wave -from Ice Surface (NSNOW=1.26)

ANG. (OEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-56.0	0.0	0.3760	1.91	0.586	0.6416	-1.9
10.0	-52.5	9.0	0.8420	1.91	0.586	1.4366	1.6
20.0	-59.0	18.0	0.1846	1.90	0.580	0.3183	-5.0
30.0	-61.5	28.0	0.1029	1.89	0.577	0.1782	-7.5
40.0	-60.0	37.0	0.1364	1.86	0.559	0.2438	-6.1
50.0	-59.5	46.0	0.1371	1.81	0.529	0.2589	-5.9
60.0	-59.0	55.0	0.1270	1.73	0.481	0.2640	-5.8
70.0	-55.5	62.0	0.1519	1.48	0.352	0.4319	-3.6
80.0	-62.0	69.0	0.0084	1.04	0.160	0.0525	-12.8



DATA GROUP NUMBER 39

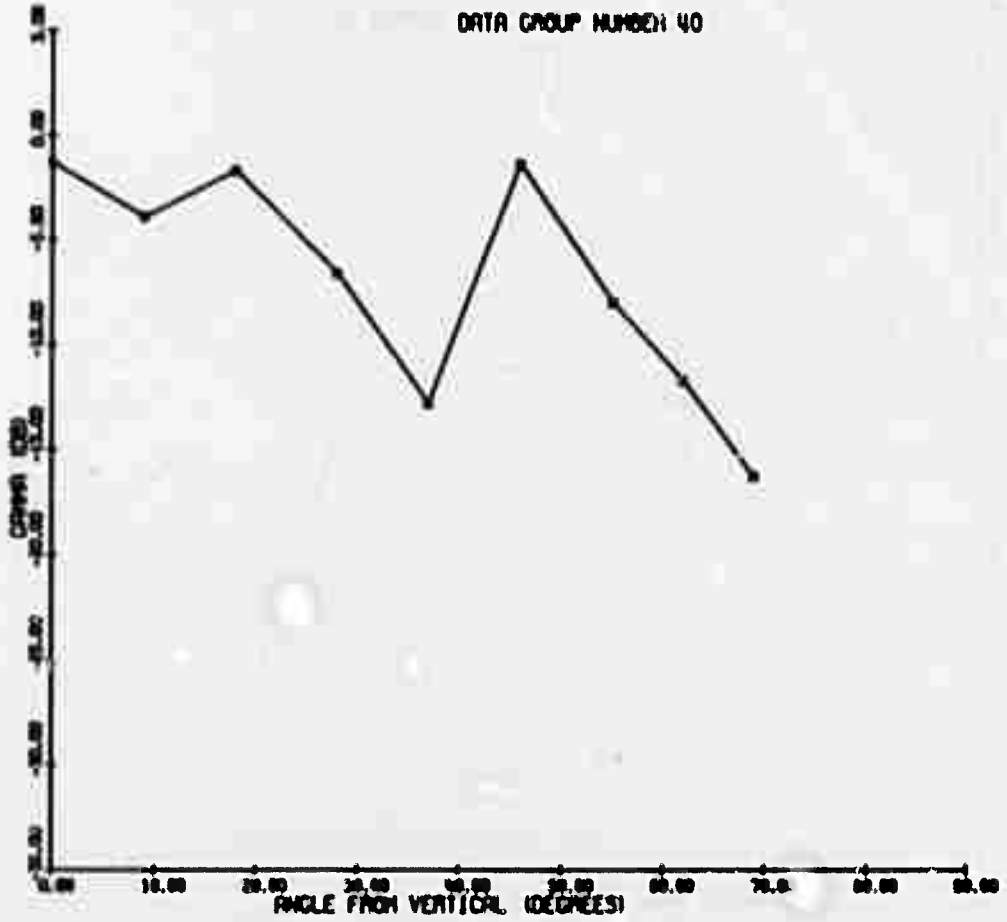
Pt. Barrow, Elson Lagoon 3/31/72 Smooth Sea Ice

Air Temp. -22C Ice Surface Temp -24C Salinity 7.2 PPT

Snow Depth 8 cm Snow Density 0.326

Vert. Wave -from Ice Surface (NSNOW=1.26)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.5	0.0	0.2114	1.91	0.586	0.3608	-4.4
10.0	-63.5	9.2	0.0670	1.91	0.587	0.1142	-9.4
20.0	-62.0	18.3	0.0932	1.90	0.582	0.1601	-8.0
30.0	-66.5	28.3	0.0329	1.90	0.581	0.0567	-12.5
40.0	-65.0	37.5	0.0443	1.88	0.567	0.0781	-11.1
50.0	-63.0	46.7	0.0642	1.84	0.542	0.1184	-9.3
60.0	-62.0	55.8	0.0690	1.76	0.501	0.1377	-8.6
70.0	-62.5	63.8	0.0383	1.57	0.395	0.0968	-10.1
80.0	-67.0	70.8	0.0036	1.13	0.195	0.0186	-17.3



DATA GROUP NUMBER 40

Experimental Farm 4/25/72 Wet Snow Surface

Air Temp. +3C

Snow Depth 49 cm

Horiz. Wave -from Snow Surface

Temp. Profile

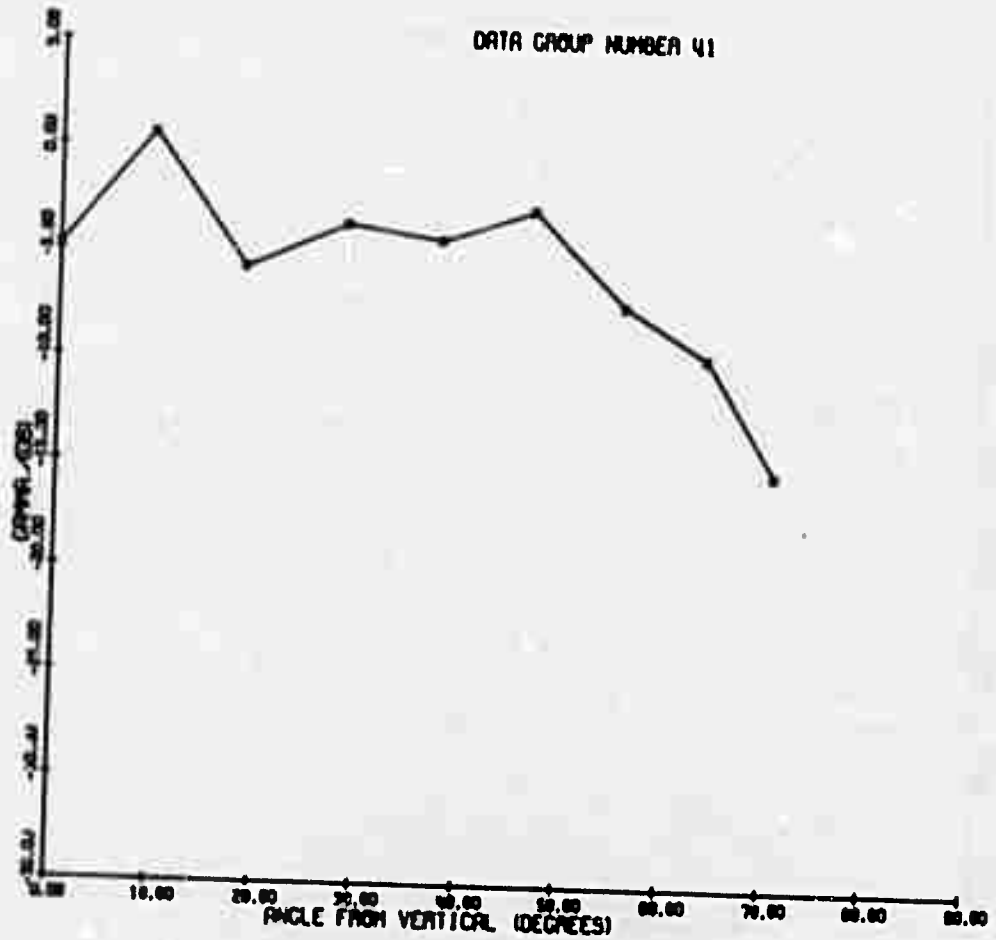
0 cm 0 C

19 cm -1 C

35 cm -1 C

49 cm 0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-55.0	0.0	0.3988	1.83	0.538	0.7414	-1.3
10.0	-57.5	9.0	0.2217	1.82	0.535	0.4145	-3.8
20.0	-55.0	18.0	0.3801	1.81	0.525	0.7238	-1.4
30.0	-59.5	28.0	0.1310	1.79	0.518	0.2531	-6.0
40.0	-65.0	37.0	0.0338	1.75	0.495	0.0682	-11.7
50.0	-52.5	46.0	0.5200	1.69	0.461	1.1289	0.5
60.0	-57.5	55.0	0.1295	1.59	0.409	0.3168	-5.0
70.0	-58.0	62.0	0.0563	1.33	0.286	0.1972	-7.1
80.0	-56.5	69.0	0.0156	0.89	0.116	0.1344	-8.7



DATA GROUP NUMBER 41

Experimental Farm 4/25/72 Wet Snow Surface

Air Temp. +3C

Snow Depth 49 cm

Vert. Wave -from Snow Surface

Temp. Profile

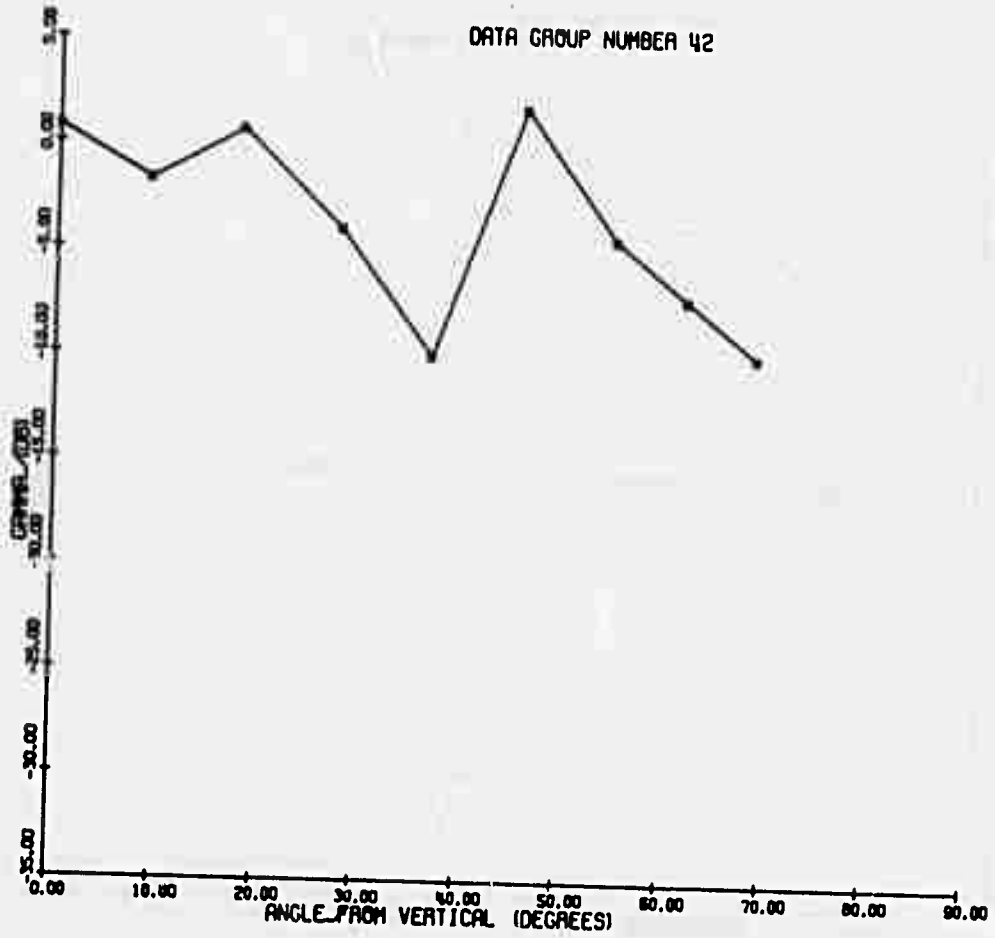
0 cm 0 C

19 cm -1 C

35 cm -1 C

49 cm 0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.5	0.0	0.1782	1.83	0.538	0.3312	-4.8
10.0	-53.0	9.2	0.6260	1.82	0.535	1.1694	0.7
20.0	-59.0	18.3	0.1525	1.81	0.527	0.2892	-5.4
30.0	-56.5	28.3	0.2646	1.80	0.521	0.5081	-2.9
40.0	-56.5	37.5	0.2454	1.77	0.502	0.4894	-3.1
50.0	-54.0	46.7	0.3863	1.71	0.472	0.8187	-0.9
60.0	-57.0	55.8	0.1581	1.63	0.426	0.3707	-4.3
70.0	-56.5	63.8	0.1021	1.42	0.324	0.3157	-5.0
80.0	-56.0	70.8	0.0247	0.97	0.143	0.1724	-7.6



DATA GROUP NUMBER 42

Experimental Farm 4/25/72 Wet Snow Surface

Air Temp. +3C

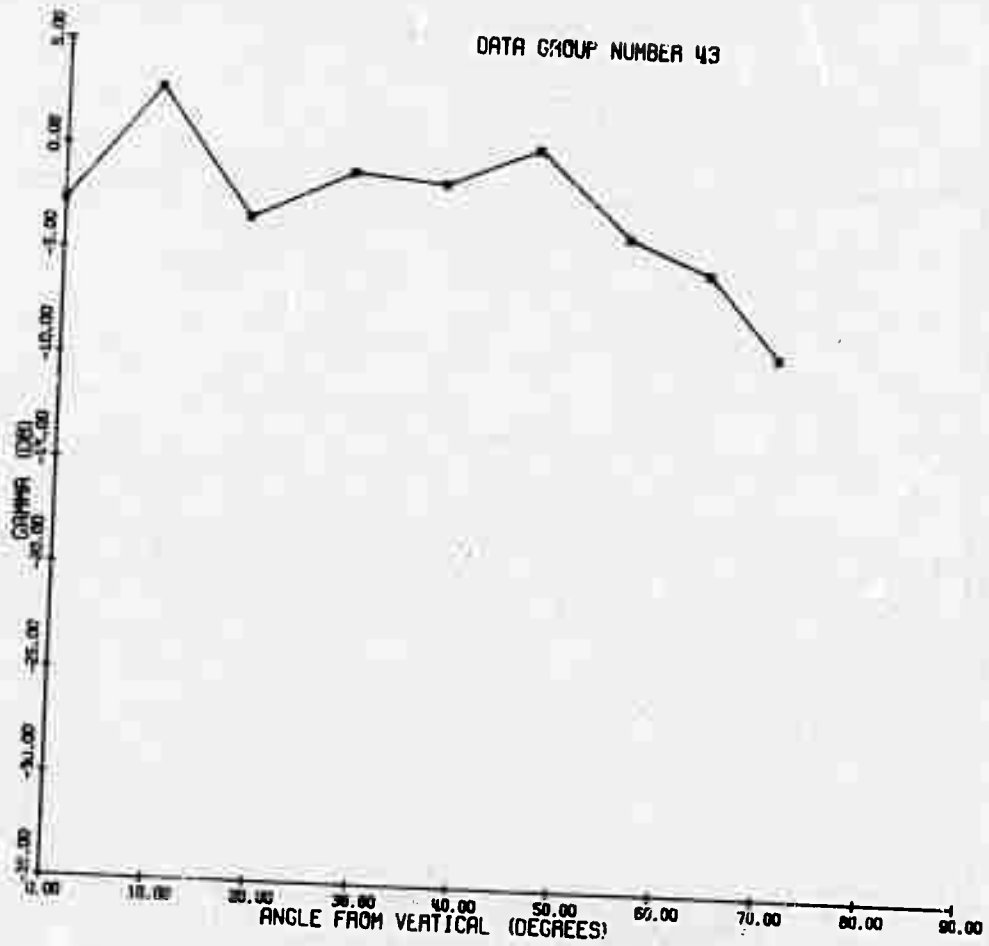
Snow Depth 49 cm

Horiz. Wave -from Ground (NSNOW=1.26)

Temp. Profile

0 cm	0 C
19 cm	-1 C
35 cm	-1 C
49 cm	0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-55.0	0.0	1.0308	2.32	0.865	1.1920	0.8
10.0	-57.5	9.0	0.6084	2.35	0.886	0.6867	-1.6
20.0	-55.0	18.0	1.1268	2.37	0.904	1.2462	1.0
30.0	-59.5	28.0	0.4284	2.41	0.936	0.4577	-3.4
40.0	-65.0	37.0	0.1248	2.43	0.951	0.1311	-8.8
50.0	-52.5	46.0	2.2484	2.44	0.958	2.3475	3.7
60.0	-57.5	55.0	0.6906	2.42	0.944	0.7316	-1.4
70.0	-58.0	62.0	0.4404	2.23	0.798	0.5516	-2.6
80.0	-56.5	69.0	0.2949	1.85	0.504	0.5852	-2.3



DATA GROUP NUMBER 43

Experimental Farm 4/25/72 Wet Snow Surface

Air Temp. +3C

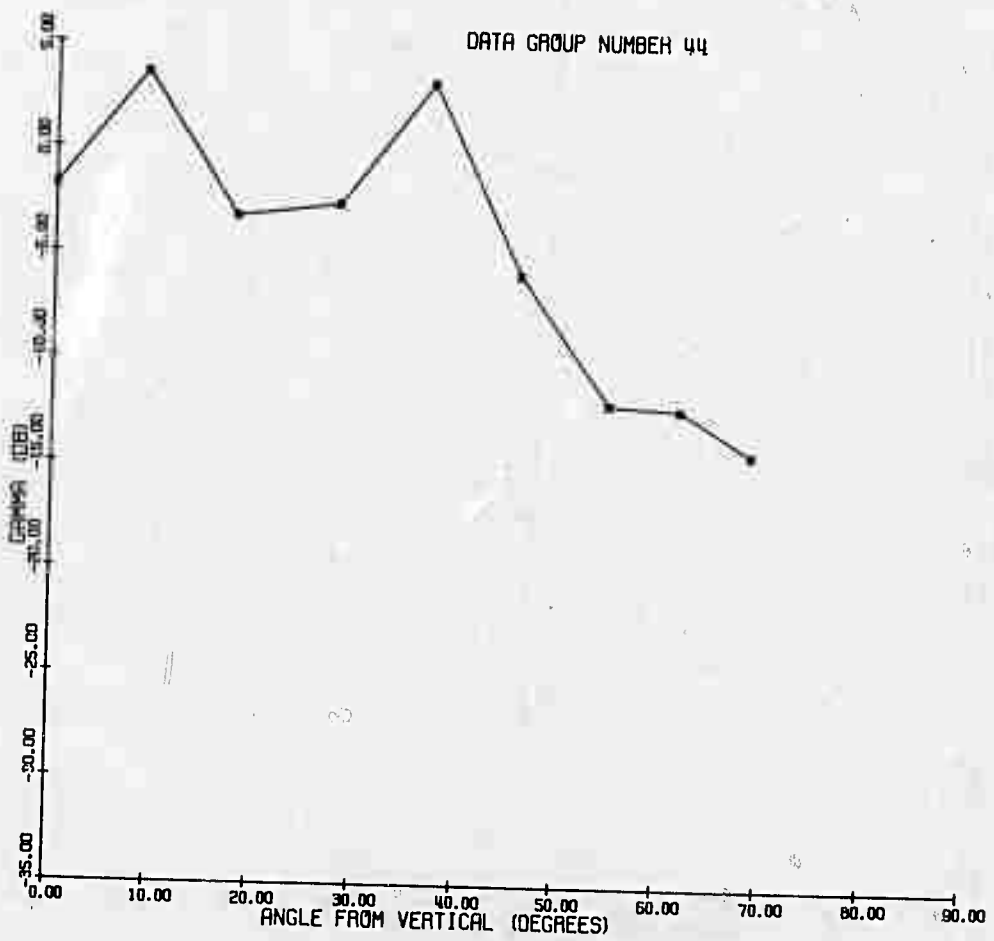
Snow Depth 49 cm

Vert. Wave -from Ground (NSNOW=1.26)

Temp. Profile

0 cm	0 C
19 cm	-1 C
35 cm	-1 C
49 cm	0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-58.5	0.0	0.4604	2.32	0.865	0.5324	-2.7
10.0	-53.0	9.2	1.7194	2.35	0.887	1.9380	2.9
20.0	-59.0	18.3	0.4524	2.38	0.908	0.4982	-3.0
30.0	-56.5	28.3	0.8656	2.42	0.942	0.9190	-0.4
40.0	-56.5	37.5	0.9056	2.45	0.963	0.9401	-0.3
50.0	-54.0	46.7	1.6610	2.47	0.978	1.6977	2.3
60.0	-57.0	55.8	0.8296	2.46	0.977	0.8494	-0.7
70.0	-56.5	63.8	0.7462	2.33	0.874	0.8533	-0.7
80.0	-56.0	70.8	0.4060	1.95	0.581	0.6985	-1.6



DATA GROUP NUMBER 44

Experimental Farm 4/26/72 Dry Snow Surface

Air Temp. -2C

Snow Depth 50 cm Snow Density (Surface) 0.290

Horiz. Wave -from Snow Surface

Temp. Profile

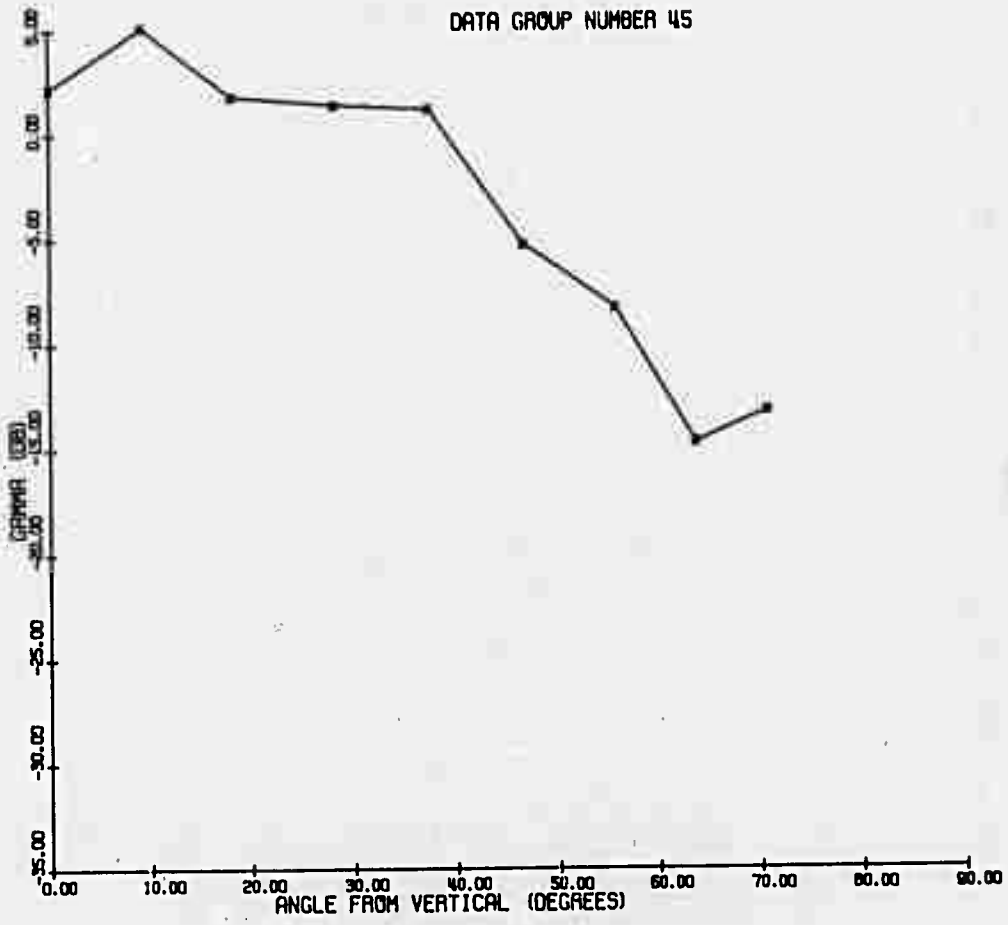
0 cm -1.5 C

11 cm -0.5 C

28 cm -0.5 C

50 cm -1.0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-55.5	0.0	0.3555	1.83	0.538	0.6608	-1.8
10.0	-50.0	9.0	1.2466	1.82	0.535	2.3309	3.7
20.0	-56.5	18.0	0.2691	1.81	0.525	0.5124	-2.9
30.0	-55.5	28.0	0.3290	1.79	0.518	0.6357	-2.0
40.0	-49.0	37.0	1.3440	1.75	0.495	2.7157	4.3
50.0	-57.0	46.0	0.1845	1.69	0.461	0.4006	-4.0
60.0	-61.5	55.0	0.0516	1.59	0.409	0.1261	-9.0
70.0	-58.5	62.0	0.0502	1.33	0.286	0.1758	-7.6
80.0	-54.5	69.0	0.0247	0.89	0.116	0.2131	-6.7



DATA GROUP NUMBER 45

Experimental Farm 4/26/72 Dry Snow Surface Temp. Profile

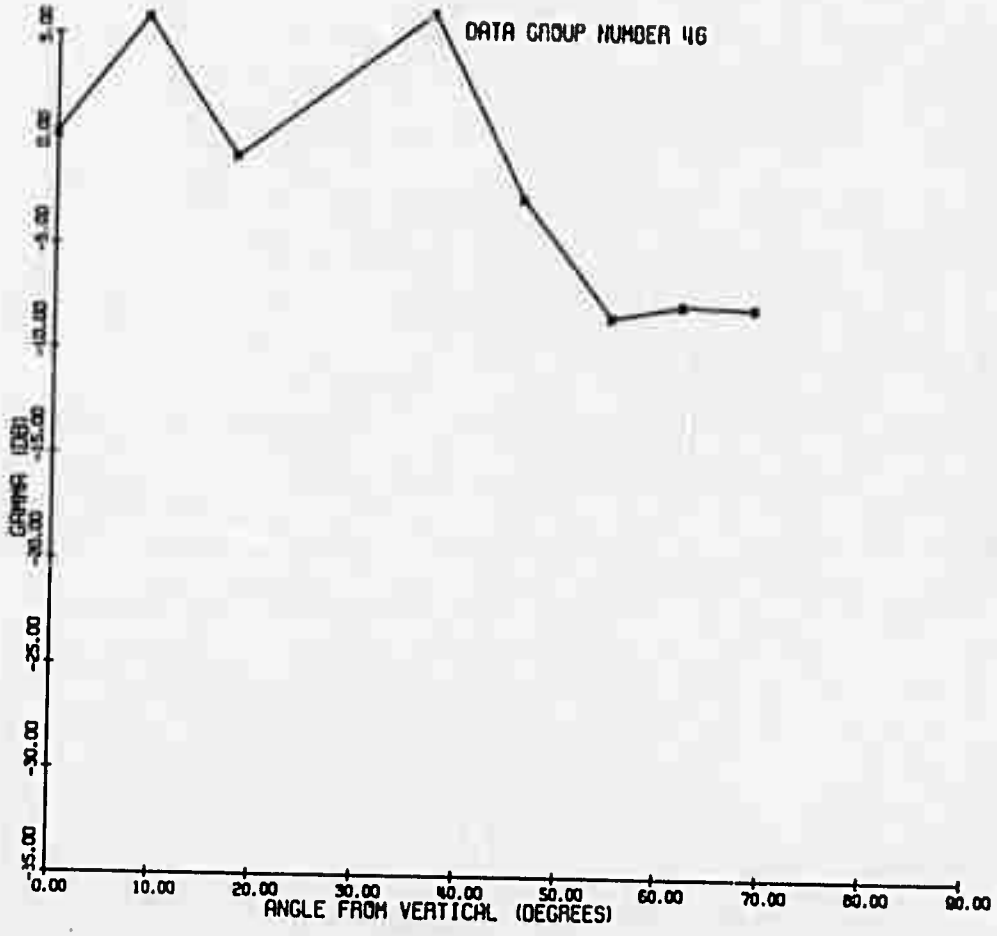
Air Temp. -2C 0 cm -1.5 C

Snow Depth 50 cm Snow Density (Surface) 0.290 11 cm -0.5 C

Vert. Wave -from Snow Surface 28 cm -0.5 C

50 cm -1.0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-51.5	0.0	0.8929	1.83	0.538	1.6599	2.2
10.0	-48.5	9.2	1.7642	1.82	0.535	3.2957	5.2
20.0	-51.5	18.3	0.8574	1.81	0.527	1.6266	2.1
30.0	-51.5	28.3	0.8366	1.80	0.521	1.6067	2.1
40.0	-51.0	37.5	0.8708	1.77	0.502	1.7364	2.4
50.0	-56.5	46.7	0.2172	1.71	0.472	0.4604	-3.4
60.0	-58.0	55.8	0.1255	1.63	0.426	0.2945	-5.3
70.0	-61.5	63.8	0.0323	1.42	0.324	0.0998	-10.0
80.0	-54.0	70.8	0.0392	0.97	0.143	0.2732	-5.6



DATA GROUP NUMBER 46

Experimental Farm 4/26/72 Dry Snow Surface

Air Temp. -2C

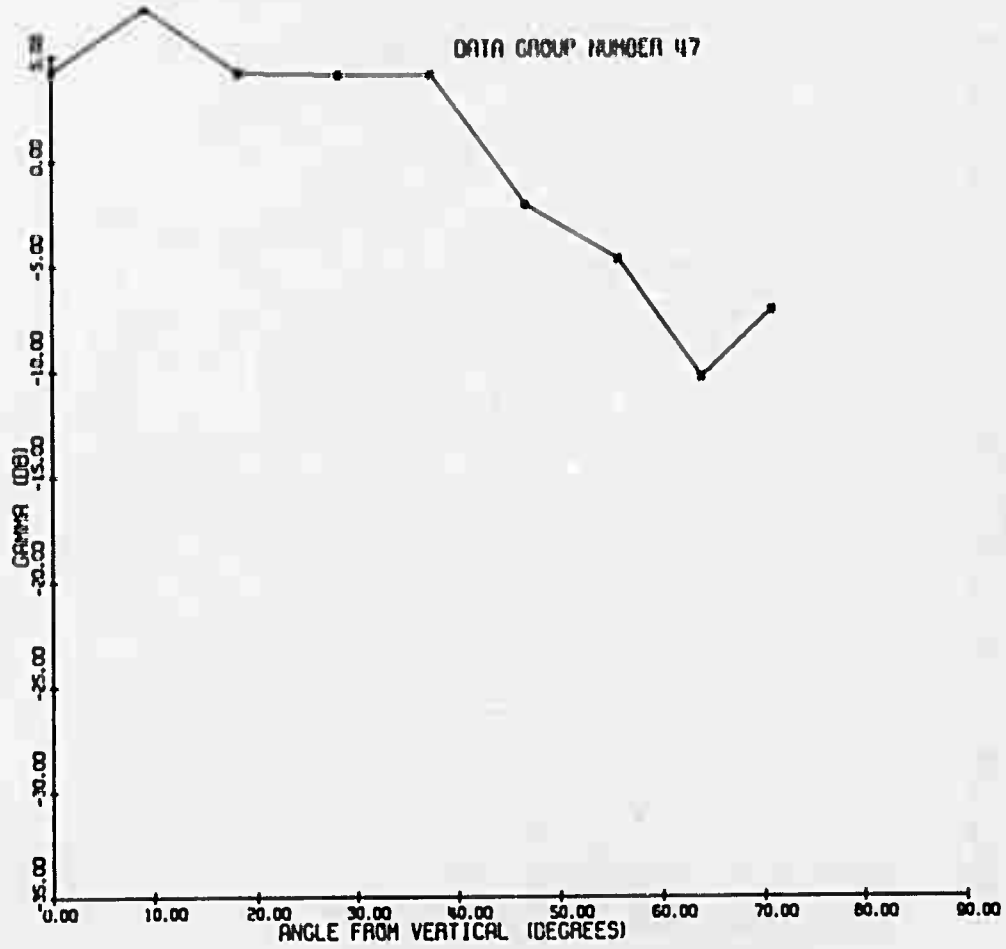
Snow Depth 50 cm Snow Density (Surface) 0.290

Horiz. Wave -from Ground (NSNOW=1.26)

Temp. Profile

0 cm	-1.5 C
11 cm	-0.5 C
28 cm	-0.5 C
50 cm	-1.0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-55.5	0.0	0.9347	2.33	0.872	1.0715	0.3
10.0	-50.0	9.0	3.4842	2.36	0.894	3.8969	5.9
20.0	-56.5	18.0	0.8133	2.38	0.913	0.8918	-0.5
30.0	-55.5	28.0	1.0989	2.42	0.946	1.1619	0.7
40.0	-49.0	37.0	5.0808	2.45	0.962	5.2801	7.2
50.0	-57.0	46.0	0.8179	2.46	0.970	0.8434	-0.7
60.0	-61.5	55.0	0.2827	2.44	0.957	0.2954	-5.3
70.0	-58.5	62.0	0.4055	2.25	0.812	0.4997	-3.0
80.0	-54.5	69.0	0.4876	1.87	0.515	0.9474	-0.2



DATA GROUP NUMBER 47

Experimental Farm 4.26/72 Dry Snow Surface Temp. Profile

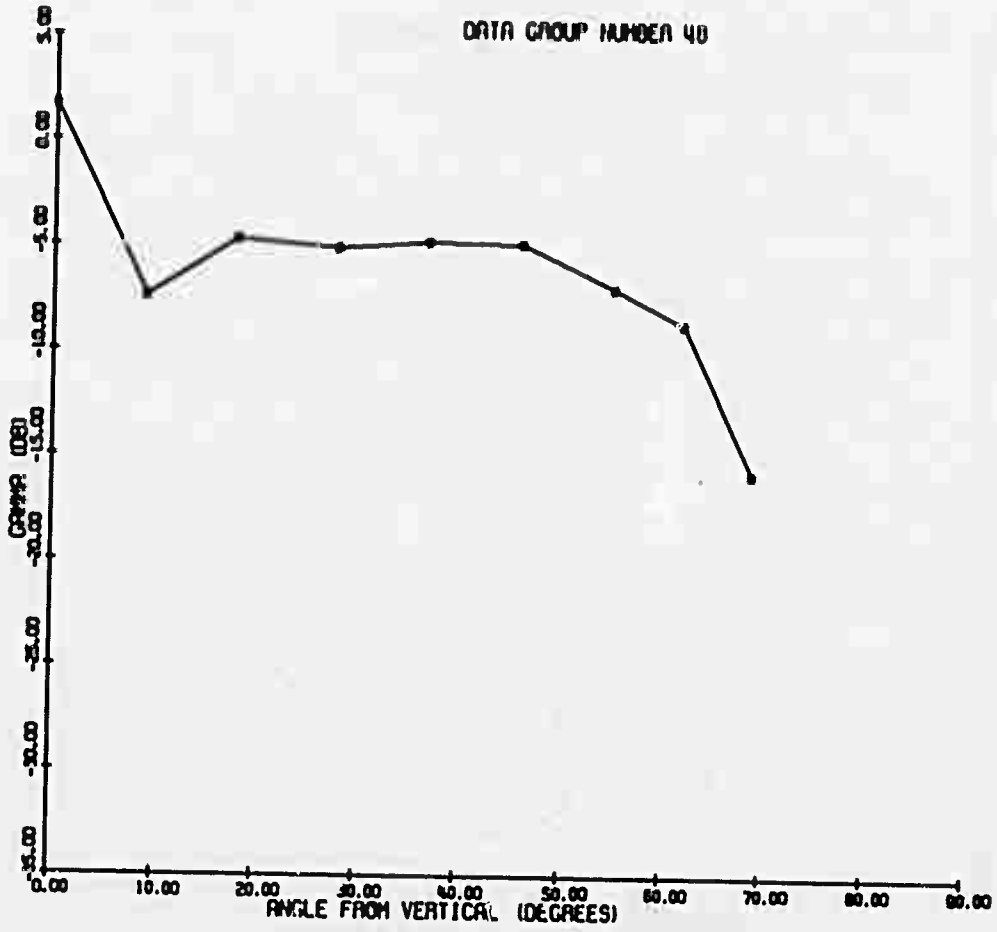
Air Temp. -2C 0 cm -1.5 C

Snow Depth 50 cm Snow Density (Surface) 0.290 11 cm -0.5 C

Vert. Wave -from Ground (NSNOW=1.26) 28 cm -0.5 C

50 cm -1.0 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-51.5	0.0	2.3478	2.33	0.872	2.6915	4.3
10.0	-48.5	9.2	4.9347	2.36	0.895	5.5120	7.4
20.0	-51.5	18.3	2.5938	2.39	0.917	2.8291	4.5
30.0	-51.5	28.3	2.7950	2.43	0.952	2.9368	4.7
40.0	-51.0	37.5	3.2870	2.46	0.974	3.3735	5.3
50.0	-56.5	46.7	0.9576	2.48	0.991	0.9666	-0.1
60.0	-58.0	55.8	0.6775	2.48	0.990	0.6841	-1.6
70.0	-61.5	63.8	0.2436	2.35	0.889	0.2742	-5.6
80.0	-54.0	70.8	0.6703	1.97	0.593	1.1299	0.5



DATA GROUP NUMBER 48

Mier Lake 4/28/72 Snow Over Fresh Lake Ice

Air Temp. -1C

Snow Depth 28 cm

Snow Density

8 cm 0.302

23 cm 0.420

Temp. Profile

0 cm 0 C

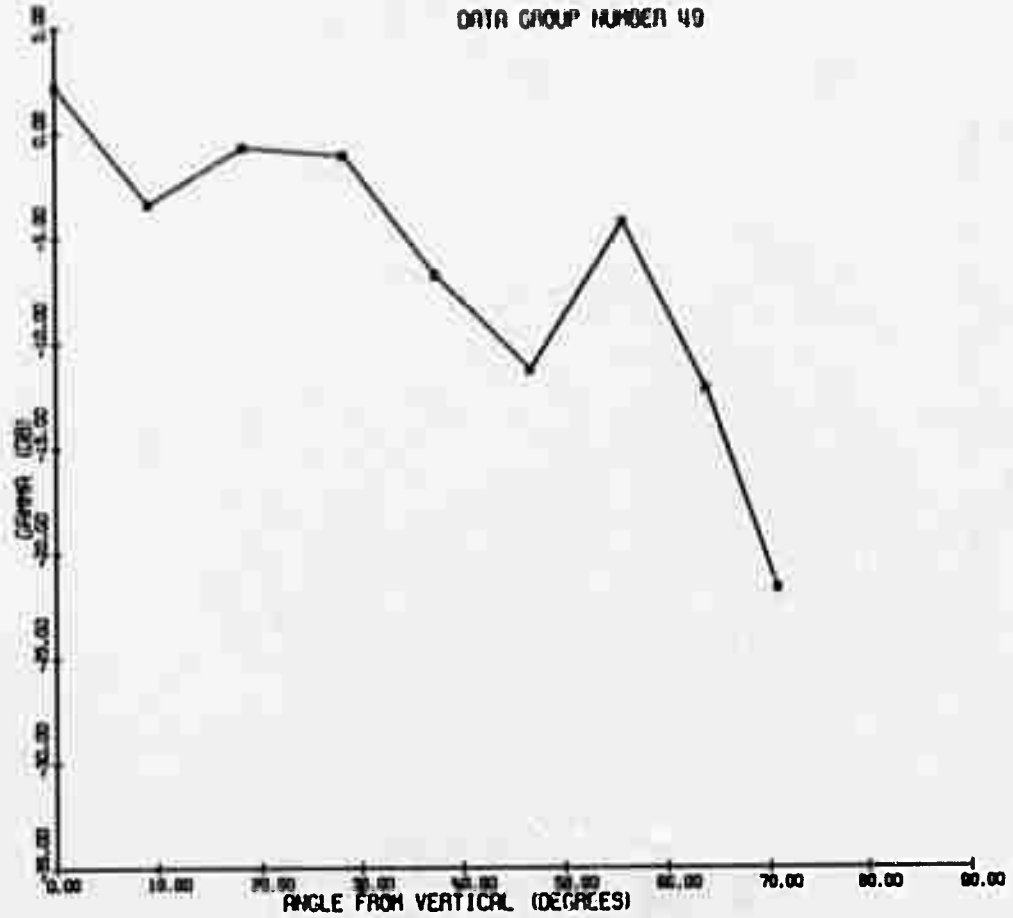
4 cm 0 C

14 cm -2 C

28 cm -2 C

Horiz. Wave -from Snow Surface

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-52.0	0.0	0.7958	1.83	0.538	1.4793	1.7
10.0	-61.0	9.0	0.0990	1.82	0.535	0.1852	-7.3
20.0	-58.0	18.0	0.1905	1.81	0.525	0.3628	-4.4
30.0	-58.0	28.0	0.1850	1.79	0.518	0.3575	-4.5
40.0	-57.0	37.0	0.2130	1.75	0.495	0.4304	-3.7
50.0	-56.0	46.0	0.2323	1.69	0.461	0.5043	-3.0
60.0	-56.5	55.0	0.1630	1.59	0.409	0.3989	-4.0
70.0	-55.0	62.0	0.1123	1.33	0.286	0.3935	-4.1
80.0	-56.0	69.0	0.0175	0.89	0.116	0.1508	-8.2



DATA GROUP NUMBER 49

Mier Lake 4/28/72 Snow Over Fresh Lake Ice Temp. Profile

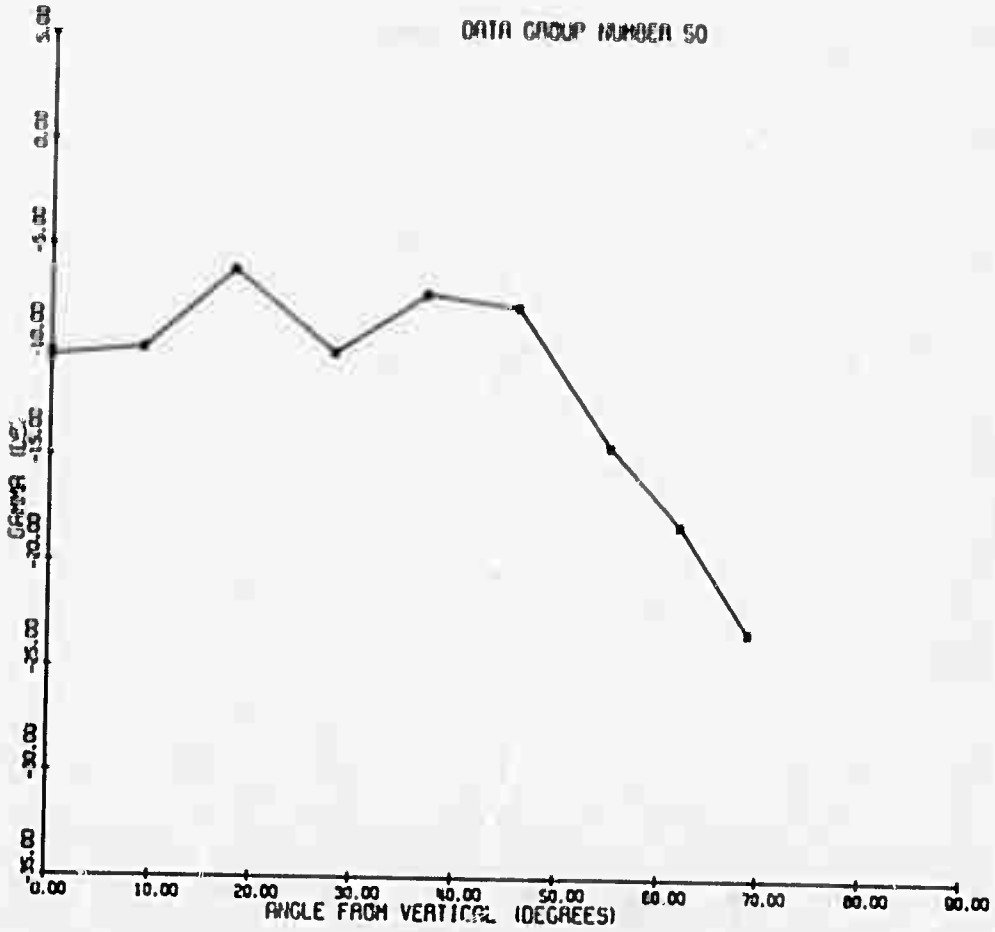
Air Temp. -1C Snow Density 0 cm 0 C

Snow Depth 28 cm 8 cm 0.302 4 cm 0 C

23 cm 0.420 14 cm -2 C

Vert. Wave -from Snow Surface 28 cm -2 C

ANG. (DEG.)	PR/PT (DB)	EFF ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-51.5	0.0	0.8929	1.83	0.538	1.6599	2.2
10.0	-57.0	9.2	0.2492	1.82	0.535	0.4655	-3.3
20.0	-54.0	18.3	0.4822	1.81	0.527	0.9147	-0.4
30.0	-54.0	28.3	0.4705	1.80	0.521	0.9035	-0.4
40.0	-59.0	37.5	0.1380	1.77	0.502	0.2752	-5.6
50.0	-62.5	46.7	0.0546	1.71	0.472	0.1156	-9.4
60.0	-54.0	55.8	0.3154	1.63	0.426	0.7397	-1.3
70.0	-59.0	63.8	0.0574	1.42	0.324	0.1775	-7.5
80.0	-62.5	70.8	0.0055	0.97	0.143	0.0386	-14.1



DATA GROUP NUMBER 50

Mier Lake 4/28/72 Snow Over Fresh Lake Ice Temp. Profile

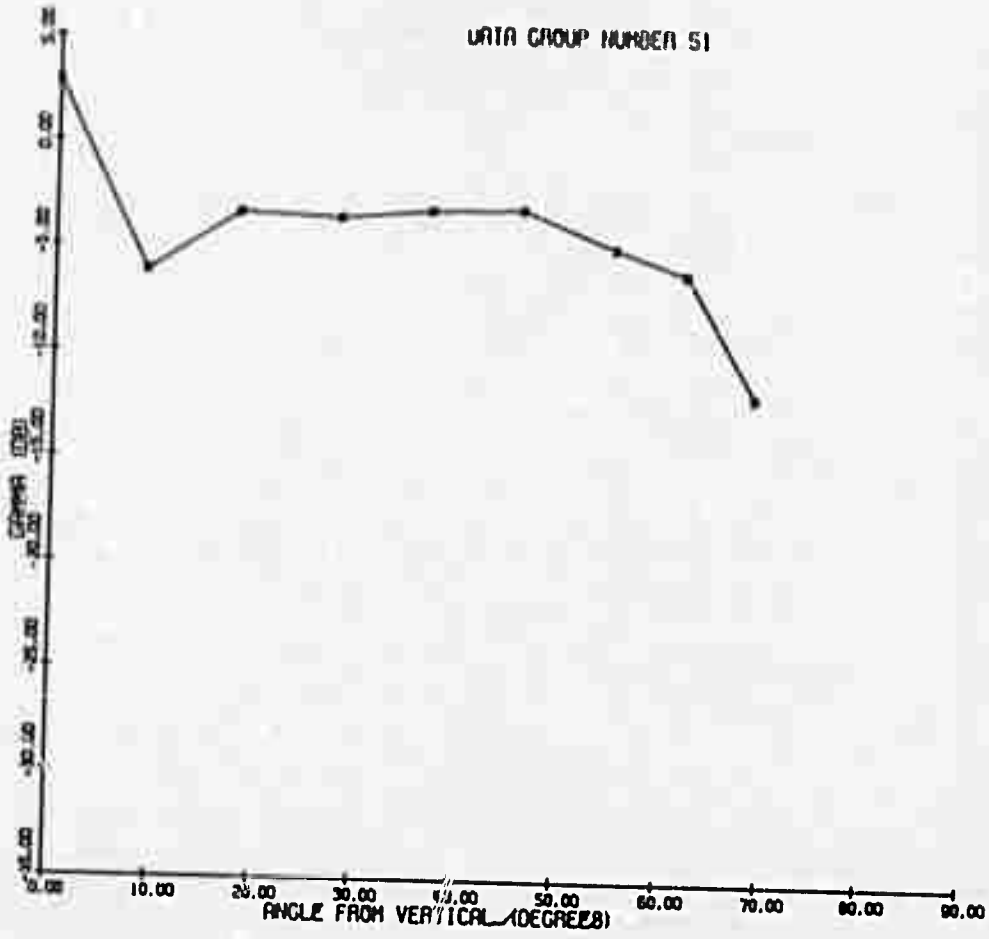
Air Temp. -1C Snow Density 0 cm 0 C

Snow Depth 28 cm 8 cm 0.302 4 cm 0 C

23 cm 0.420 14 cm -2 C

Orth. WAve -from Snow Surface 28 cm -2 C

ANG. (DEG.)	PR/PT (DB)	EFF ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-64.0	0.0	0.0502	1.83	0.538	0.0933	-10.3
10.0	-63.5	9.0	0.0557	1.82	0.535	0.1041	-9.8
20.0	-59.5	18.0	0.1349	1.81	0.525	0.2568	-5.9
30.0	-63.0	28.0	0.0585	1.79	0.518	0.1130	-9.5
40.0	-59.5	37.0	0.1198	1.75	0.495	0.2420	-6.2
50.0	-59.0	46.0	0.1164	1.69	0.461	0.2527	-6.0
60.0	-64.0	55.0	0.0290	1.59	0.409	0.0709	-11.5
70.0	-64.5	62.0	0.0126	1.33	0.286	0.0442	-13.6
80.0	-63.5	69.0	0.0031	0.89	0.116	0.0268	-15.7



DATA GROUP NUMBER 51

Mier Lake 4/28/72

Air Temp. -1C

Snow Depth 28 cm

Snow Over Fresh Lake Ice

Snow Density

8 cm 0.302

23 cm 0.420

Temp. Profile

0 cm 0 C

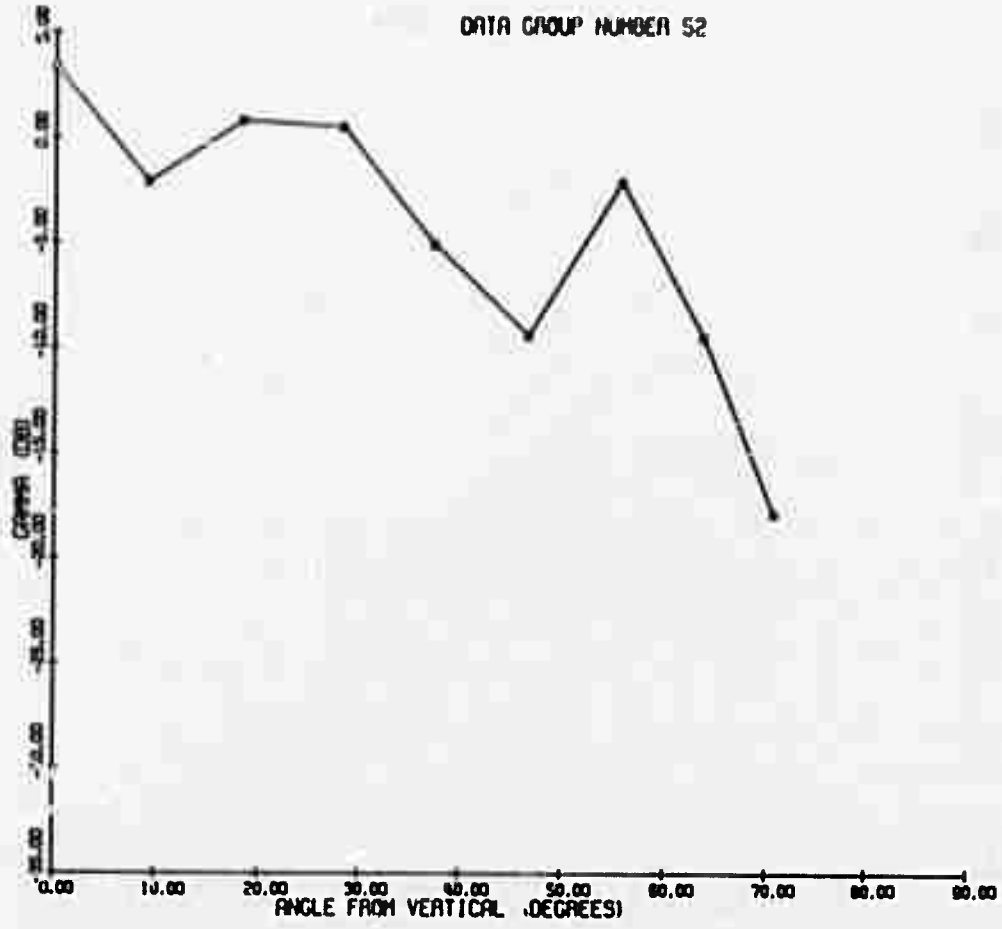
4 cm 0 C

14 cm -2 C

28 cm -2 C

Horiz. Wave -from Ice Surface (NSNOW=1.30)

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-52.0	0.0	1.4069	2.11	0.715	1.9679	2.9
10.0	-61.0	9.0	0.1816	2.12	0.724	0.2507	-6.0
20.0	-58.0	18.0	0.3662	2.13	0.728	0.5030	-3.0
30.0	-58.0	28.0	0.3776	2.14	0.739	0.5108	-2.9
40.0	-57.0	37.0	0.4685	2.14	0.734	0.6383	-1.9
50.0	-56.0	46.0	0.5627	2.11	0.717	0.7849	-1.1
60.0	-56.5	55.0	0.4498	2.05	0.679	0.6625	-1.8
70.0	-55.0	62.0	0.3970	1.83	0.537	0.7397	-1.3
80.0	-56.0	69.0	0.1131	1.41	0.295	0.3838	-4.2



DATA GROUP NUMBER 52

Mier Lake 4/28/72 Snow Over Fresh Lake Ice Temp. Profile

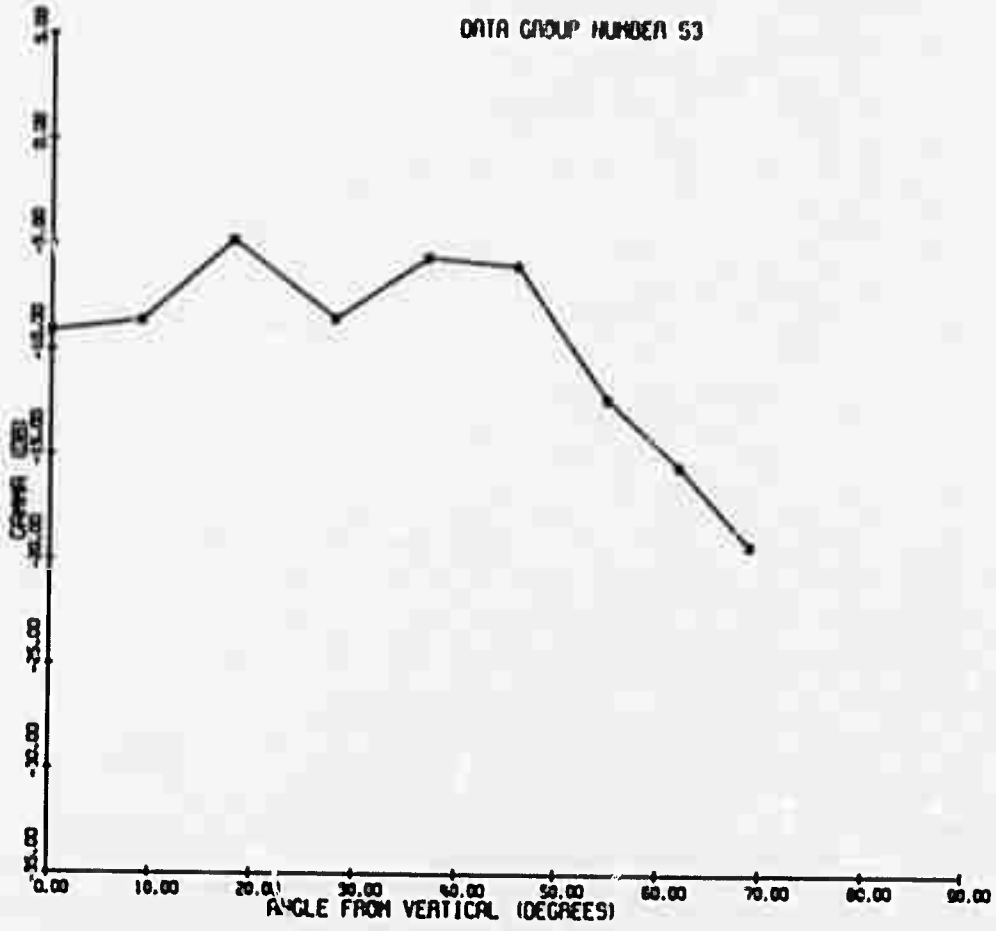
Air Temp. -1C Snow Density 0 cm 0 C

Snow Depth 28 cm 8 cm 0.302 4 cm 0 C

23 cm 0.420 14 cm -2 C

Vert. Wave -from Ice Surface (NSNOW=1.30) 28 cm -2 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-51.5	0.0	1.5786	2.11	0.715	2.2070	3.4
10.0	-57.0	9.2	0.4572	2.12	0.725	0.6306	-2.0
20.0	-54.0	18.3	0.9273	2.13	0.731	1.2685	1.0
30.0	-54.0	28.3	0.9603	2.15	0.744	1.2909	1.1
40.0	-59.0	37.5	0.3032	2.15	0.743	0.4079	-3.9
50.0	-62.5	46.7	0.1317	2.13	0.733	0.1796	-7.5
60.0	-54.0	55.8	0.8605	2.09	0.704	1.2219	0.9
70.0	-59.0	63.8	0.1935	1.92	0.594	0.3258	-4.9
80.0	-62.5	70.8	0.0323	1.50	0.346	0.0932	-10.3



DATA GROUP NUMBER 53

Mier Lake 4/28/72 Snow Over Fresh Lake Ice Temp. Profile

Air Temp. -1C Snow Density 0 cm 0 C

Snow Depth 28 cm 8 cm 0.302 4 cm 0 C

23 cm 0.420 14 cm -2 C

Orth. Wave -from Ice Surface (NSNOW=1.30) 28 cm -2 C

ANG. (DEG.)	PR/PT (DB)	EFF. ANG.	SIGMA (MET. SQ.)	MN. RAY (MET.)	NORM. AREA (MET. SQ.)	GAMMA	(DB)
0.0	-64.0	0.0	0.0888	2.11	0.715	0.1241	-9.1
10.0	-63.5	9.0	0.1021	2.12	0.724	0.1410	-8.5
20.0	-59.5	18.0	0.2593	2.13	0.728	0.3561	-4.5
30.0	-63.0	28.0	0.1194	2.14	0.739	0.1615	-7.9
40.0	-59.5	37.0	0.2635	2.14	0.734	0.3590	-4.4
50.0	-59.0	46.0	0.2820	2.11	0.717	0.3934	-4.1
60.0	-64.0	55.0	0.0800	2.05	0.679	0.1178	-9.3
70.0	-64.5	62.0	0.0445	1.83	0.537	0.0830	-10.8
80.0	-63.5	69.0	0.0201	1.41	0.295	0.0683	-11.7